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MONITORING AGRICULTURAL PESTICIDE RESIDUES 1965-1967

A Final Report on Soil, Crops, Water, Sediment, and Wildlife in Six Study Areas

Agricultural Research Service
United States Department of Agriculture

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife -- if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

PROTECT

Use Pesticides Safely

FOLLOW THE LABEL

U.S. DEPARTMENT OF AGRICULTURE

TABLE OF CONTENTS

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Plant Pest Control Division
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INTRODUCTION

Following the recommendations of the President's Science Advisory Committee in its 1963 report, the U.S. Department of Agriculture established a pilot study in the Mississippi Delta to monitor agricultural pesticides. This program was established in 1964 through close cooperation of those Divisions of the Agricultural Research Service whose work involves the use of pesticides. Plant Pest Control, Entomology Research, Pesticides Regulation, and Animal Health were most active in designing and implementing the program. Biometrical Services Staff assisted in planning the program. The Plant Pest Control Division assumed primary responsibility for conducting operations.

The objectives were: (a) to determine existing pesticide levels in soils, crops, water, sediment, and local species of aquatic and terrestrial organisms (livestock were also sampled when available); and (b) to determine changes in pesticide levels that occurred during the course of the study.

At the onset, paired 1-square-mile study areas were selected at each of five locations in the Mississippi Delta. The first year's data (1)[1] showed no significant variation between pair members, so one area was dropped at each location. The remaining pair member was abandoned at one location in Mississippi and at one location in Arkansas.

Late in 1964 and early in 1965, the program was expanded to include study areas at Grand Forks, N. Dak.; Yuma, Ariz.; and Mobile, Ala.

This report includes analytical results and discussion of pesticide residues found in soils, crops, water, sediment, and aquatic and terrestrial organisms. The data contained in this report were collected in 1965 and 1966 in the Delta areas, and were collected in 1965, 1966 and 1967 at Grand Forks, Mobile, and Yuma. About 1,800 samples were analyzed in 1965, 1,800 in 1966, and 1,000 in 1967.

The first sections will describe sampling procedures and methods of analysis, then each study area will be described and discussed individually.

Arsenic data for all areas are listed at the end of this report for reasons explained there.

[1] Underscored letters in parentheses refer to Literature Cited, page 97.

FIELD SAMPLING PROCEDURES

Each sampling season began with the "spring" soil sampling before the major pesticide applications and progressed through the growing and harvest seasons to the "fall" soil sampling at the conclusion of the pest-control season. The materials sampled included soil, crops, contained surface water, quick runoff water, irrigation water, potable well water, sediment, terrestrial organisms, aquatic organisms, and available farm animals. Sample data sheets bearing information pertinent to sample collection accompanied each sample to the processing and analytical laboratories.

Each study area was subdivided into blocks ranging from 5 to 60 acres in size. Each block (usually one field) represented a single land use.

Soil

Soil samples were collected from each block before and after the pesticide application season each year. Three samples were taken from each block at every sampling. A sample consisted of a composite of one core per acre taken on a stratified random basis. The soil cores, 2 inches in diameter by 3 inches deep, were pulled with a tubular core sampler. The soil was thoroughly screened with 1/4-inch mesh screen to insure mixing and to screen out such things as stones, roots, twigs, and grass. A representative portion of the resulting mixture was placed in an airtight container and held for processing.

Water

Water from contained surface sources, quick runoff, and irrigation was drawn into 5-gallon carboys with a hand-operated pump from several points in the source and, in the case of contained sources, from various depths. Potable well water was drawn directly from the source into the carboy.

Contained surface water sources that received drainage from within the study area were sampled at about 2-week intervals during the pest-control season and monthly during the off season.

Quick-runoff water was collected after heavy rainfall at points where it entered contained sources or collected at the end of a block.

Potable well water was sampled at 3-month intervals. The samplings were immediately before, during, and after the pest-control season. No pesticide residues at all were found in potable water, so there will be no further discussion of potable water in this report.

Irrigation water was collected from selected blocks every time they were irrigated. One sample was taken as water entered the block and another as it exited or collected at the end of the block.

Sediment

Sediment cores were randomly collected from contained surface sources and, in a few instances, where quick-runoff water was collected. A core sampler was used to pull 25 cores of sediment at each sample site. The sampler was forced through the sediment to solid earth before being withdrawn. The cores were thoroughly mixed, the water was decanted, and a part of the composite was retained for analysis.

Crops

Each different crop grown in a study area was sampled immediately before or at harvest-time. Representative samples were collected on a stratified random basis from five 1-acre plots within each selected block.

By using a "dual sampling" technique, soil samples were collected with each crop sample. One man collected soil, while another collected the crop sample. The soil samples were obtained from composites of 50 cores collected on a stratified random basis from each plot. Plant material was collected adjacent to each core site or every other core site, depending upon the bulkiness of the crop. Some crops, such as lettuce, were analyzed as a single sample, and others, such as soybeans (beans and plants), were analyzed as two or more subsamples.

Pasture forage was sampled in a slightly different way. The object was to detect residues resulting from drift of pesticides from applications on adjacent fields. Pasture blocks were divided into thirds, with one third lying parallel to a block or blocks where pesticides were being used and the other two parallel to the first. Handfuls of forage were collected from random points within each third and composited into three samples. Samples were collected monthly during the pest-control season. There was no corresponding soil sampling.

Terrestrial Organisms

Several local species of terrestrial organisms were collected before and after the pest-control season each year. Specimens were collected alive whenever possible. Included in the collection were several species of small mammals, a few reptiles, bird nestlings and eggs, terrestrial snails, and earthworms. In order to obtain a minimum of 150 g. in each sample, some samples were composites of several individuals of the same species. The numbers of individuals per sample were set at: 10 for small mammals; 5 for rabbits; 10 for nestling birds; and 6 to 12 for bird eggs.

Aquatic Organisms

Aquatic organisms, including fish, turtles, mussels, and crayfish, were periodically sampled in areas with contained surface water sources. Collections were made with traps, nets, sieves, and lines. Here again, specimens were composited by species. Samples of the larger species generally consisted of 10 individuals, while samples of the smaller species consisted of 25 to 50. Other aquatic organisms, such as algae, frogs, tadpoles, and toads, were collected whenever available.

Farm Animals

When available, samples were taken from slaughtered cattle, poultry, and eggs. Fatty tissue (two pounds) was collected from each of the cattle. Samples of poultry and eggs were each composites of four and 24 individuals, respectively.

CROPPING AND PESTICIDE USE RECORDS

Accurate records of pesticide applications were kept at each area during the study in order to learn something about the input of pesticides and to serve as a guide to the analytical chemists. Records of the crops grown and the tillage practices were also kept. In addition, an

attempt was made to obtain historical records back to the year chlorinated hydrocarbon pesticides were first used or back 10 years, whichever was earlier. Unfortunately, accurate information was very difficult to obtain because of poorly kept records, change of ownership, etc.[2] As a result, the records compiled give only a general picture of pesticide use before initiation of these studies.

METHODS OF CHEMICAL ANALYSIS

Residue analysis is dynamic and constantly changing as new methods, techniques, and equipment are developed. Cooperation between Federal, State, and industrial laboratories made possible the use of improved techniques as quickly as they were developed. In addition, the latest and best equipment available was used.

The most persistent analytical problems were unresolvable interferences, arising, at times, from an olio of pesticides present, and, at other times, from applications of complex mixtures of pesticides.

An unidentified chlorinated hydrocarbon was found at very noticeable levels in many soil and sediment samples. This unidentified material was suspected to be toxaphene and/or Strobane, indicating the need for developing a practical analytical method for those insecticides. The technique used during the first part of the study included thin-layer chromatography for separation and colorimetry for quantification. Later in the study, however, a superior method of analysis based on simple gas chromatography was put into practice.

In 1965, arbitrary limits of definition were set. For soils and sediments, the sensitivity level for all chlorinated hydrocarbons except toxaphene/Strobone (0.5 p.p.m.) was 0.05 p.p.m. Residues less than 0.10 p.p.m., but greater than 0.05 p.p.m., were reported as 0.08 p.p.m. For water, residues between 0.00010 p.p.m. and 0.00005 p.p.m. were recorded as 0.00008 p.p.m. and levels below 0.00005 p.p.m. were not recorded. For crops, all residues of 0.01 p.p.m. and above were recorded. By August of 1967, these arbitrary reporting limits were generally lowered because of improved analytical efficiency. After that time, most residues with the exception of those in water were reported down to 0.01 p.p.m. The lower limit for water was reset at 0.00001 p.p.m. The lowered limits were reported for some 1966 samples and for nearly all 1967 samples.

A. Equipment and Materials

1. Four F & M[3] Model 810 gas chromatographs equipped with electron capture detectors and/or flame thermionic detectors.
2. Two F & M Model 402 gas chromatographs equipped with effluent splitters for simultaneous electron capture and flame thermionic detection.
3. Two Jarrell-Ash Model 28-730 gas chromatographs with electron capture detectors.
4. Two Micro-Tek Model 220 gas chromatographs with electron capture detectors.
5. One Perkin-Elmer Model 303 atomic absorption spectrophotometer.
6. One Bausch & Lomb Model 505 UV-visible, recording spectrophotometer.
7. Two complete Brinkman thin-layer chromatography kits.
8. "Pesticide Grade" organic solvents. In most cases, these solvents were prepared at the laboratory using chemical cleanup redistillation procedures.
9. All inorganic reagents coming in contact with organic pesticide solvents were: (a) prewashed with hexane before use, or (b) checked for electron capture and flame thermionic detectable impurities.

[2] The pre-1965 records were documented at areas GRA and YUA. In addition, the dieldrin and heptachlor use records for SMO were documented.

[3] Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

B. Extraction

1. Soil. Subsamples of 300 grams wet weight were placed in 2-quart fruit jars with 600 ml. of 3:1 hexane-isopropanol solvent. The jars were sealed with aluminum foil- or Teflon-lined caps and concentrically rotated at 30 r.p.m. for 4 hours. After the soil settled, about 200 ml. of the extract solution was filtered into a 500 ml. separatory funnel. The isopropanol was removed by two washings with equal volumes of distilled water. The hexane was then filtered into a clean glass bottle through a funnel containing glass wool and anhydrous sodium sulfate (Na_2SO_4). The bottle was capped until analysis. For the most part, no further cleanup was needed before analysis.

2. Sediment. Samples of sediment, silt, or sludge were extracted in a manner similar to that for the soil samples, except that 100 g. of anhydrous sodium sulfate was added with the solvent to the extraction bottle.

3. Water. Subsamples of about 15 kg. (about 4 gallons) were decanted into clean, preweighed extraction carboys with Teflon-lined screw caps. They were reweighed, 1000 ml. of 3:1 pentane-ethyl ether was added, and the mixture was rotated 20 minutes at 30 r.p.m. on a ball-mill rotator. Next, the upper solvent phase was decanted by displacement. A 750-ml. aliquant of extract was then concentrated to about 30 ml. and rediluted to exactly 50 ml. This concentrate was then normally ready for gas chromatographic analysis without further cleanup.

4. Crops and Wildlife (less than 2% fat). Crop samples were chopped into small pieces with a forage chopper, Hobart food chopper, or both. Depending on bulk, 50- or 100-gram subsamples of the chopped material were mixed with 200 ml. of redistilled acetonitrile and macerated at high speed for several minutes in a Waring blender. The liquid was then decanted into two balanced centrifuge bottles (250 ml. capacity each) and centrifuged. The acetonitrile extract was decanted through filter paper or glass wool into a 1-liter Erlenmeyer flask. The pulp was washed back into the blender jar with another 100 ml. of acetonitrile. Extraction, centrifugation (with certain samples, centrifugation was unnecessary), and filtration were repeated, then the acetonitrile fractions were combined. The acetonitrile was boiled off to a low volume through a 3-ball Snyder column on a hot plate. The remaining acetonitrile was removed by successive azeotropic distillations (1:3 acetonitrile-hexane azeotrope, b.p. 58-59°C.) using 100 ml. and 50 ml. portions of hexane. Sample volume was reduced to about 5 ml. after each hexane addition.

With high-moisture-content samples, evaporation was continued until water droplets appeared at the neck of the flask.

Next, 100 ml. of hexane was added to the flask and brought to a boil to insure solution of the pesticides. After cooling, the hexane was transferred to a separatory funnel. The flask was rinsed successively with 5 ml. of isopropanol and 25 ml. of hexane. These washings were also put in the funnel. The isopropanol was removed by adding 50 ml. of distilled water, gently shaking the funnel, and rejecting the water layer. The hexane was filtered through a filter tube containing clean glass wool topped with 1/2 inch of granular anhydrous Na_2SO_4. The filter tube and separatory funnel were each washed with a small quantity of hexane and the final extract volume was brought to 150 ml. with fresh hexane. Aliquants of this extract were then ready for Florex and Florisil column cleanup.

5. Crops and Wildlife (more than 2% fat). Subsamples weighing between 50 and 100 grams were homogenized with 100 ml. of isopropanol in a blender for several minutes (some samples, such as soybeans and corn, were dry blended before homogenization with isopropanol). The homogenate was transferred with the aid of 400 ml. of hexane into a 2-quart fruit jar. After it was capped with an aluminum foil-lined lid, the mixture was concentrically rotated for 2 hours.

The subsample was filtered through a plug of glass wool, and 250 ml. of filtrate was collected. After the filtrate was placed in a separatory funnel, the alcohol was washed out with two successive 200 ml. portions of saturated sodium chloride solution and a final distilled water wash. The interfacial "cuff" was discarded with the distilled water wash. The hexane was then filtered, with washing, through granular anhydrous Na_2SO_4 and Pyrex wool. The solvent volume was reduced to less than 150 ml. and rediluted to that volume. Aliquants of this extract were then used for partition cleanup.

C. Sample Cleanup

1. Partitioning (for all crop and wildlife samples containing more than 2% fat). Sample extracts (containing 5 grams of actual sample) were placed in a 125 ml. separatory funnel. The volume was increased to exactly 20 ml. with hexane, and then 50 ml. of hexane-saturated acetonitrile was added. After the samples had been shaken and the layers had been allowed to separate, the acetonitrile layer was drained into a 250-ml. separatory funnel. The hexane was extracted with two additional 50-ml. portions of acetonitrile, and the combined acetonitrile phase was backwashed with 20 ml. of acetonitrile-saturated hexane. The pesticides in the acetonitrile were then transferred to hexane by the method described under B.4. above. After the hexane volume has been brought to about 5 ml., the partitioned extract was ready for Florex or Florisil column cleanup.

2. Florex or Florisil Column Chromatography (for all crop and wildlife samples). A chromatographic column (10 mm. i.d. X 21 in.) equipped with a 125-ml. reservoir and Teflon stopcock was used for all separations. Thin layers of granular anhydrous sodium sulfate (Na_2SO_4) were used above and below the absorbent layer.

Florex (20 grams, AARVM 60/100 mesh) activated at 130° C. for 16 hours was used in the early work. The columns were prewashed with 50 ml. of 10% ether in hexane, followed with 50 ml. of pure hexane. Two elutions were made: (a) 150 ml. of 10% ether in hexane; (b) 100 ml. of 15% ether in hexane. The chlorinated pesticides, plus ethyl parathion, diazinon, and phorate were eluted with the 10% ether fraction. Malathion was recovered in the 15% fraction. Azinophosmethyl was held back in both fractions, and methyl parathion split between the two elutes.

Floricil (PR grade) was used in the later work. This material gave better cleanup and could be more reproducibly activated. Adsorbent activity was adjusted so that 200-ml. elutions with 10% and 15% ether, respectively, placed ethyl parathion in the 10% fraction and methyl parathion in the 15% fraction. Dieldrin and endrin were also eluted in the 10% fraction.

D. Analysis

1. Gas Chromatography: Chlorinated Pesticides. Where it was practical, instrument amplification was set to provide halfscale deflections of aldrin at the 0.5-nanogram level.

Sample extracts showing high levels of pesticides were diluted to bring them within the linear range of the electron capture detectors. Low levels of pesticides were reported when peak heights greater than twice the "signal to noise ratio" were obtained.

Dual column confirmations (nonpolar vs. mixed polar-nonpolar or polar columns) were made in all cases when a pesticide without a clear-cut history or use was recovered.

A system of controls was designed to detect inadvertent contamination during processing and to provide recovery values for suspected or known pesticides. These controls included: (a) fortified solvent, unprocessed; (b) fortified solvent, processed; (c) unfortified solvent, processed;

(d) composite sample, fortified and processed; (e) composite sample, unfortified but processed. Recovery corrections were usually determined by subtracting residues in (e) from residues in (d) and comparing the difference with residues in (a). Typical columns used and their operating parameters were:

DC-200: 3% on 100/120 mesh Gas-Chrom Q; 180°C.; flow rate 80 ml./min.

UCW-98: 3.8% on 100/120 mesh Gas-Chrom Q; 180°C.; flow rate 80 ml./min.

QF-1: 9% on 100/120 mesh Gas-Chrom Q; 180°C; flow rate 30 ml./min.

Mixed (OV-17/QF-1): 11% on 100/120 mesh Gas-Chrom Q; 210°C.; flow rate 80 ml./min.

These parameters were based on a six-foot, U-shaped column (glass), 1/4 inch o.d. X 5/32 inch i.d.

As mentioned earlier, the initial toxaphene analyses were done with a colorimetric method (6). That method, however, was subject to manifold interferences. The gas chromatographic method finally adopted was based on taking average values from the four predominant toxaphene peaks on a nonpolar column and comparing them to the corresponding peaks from the chromatogram of a known standard. If one peak was obscured, the remaining three were used. This method appears to be accurate down to the 0.05 p.p.m. level.

2. Gas Chromatography: Organophosphate Pesticides. The phosphate pesticides were analyzed for by flame thermionic, flame photometric, or electron capture detection. In most cases, a sample splitter system with dual detection was used. This method allowed parathion detection in the presence of sulfur, which would normally mask that phosphate in electron capture.

In general, only those organophosphates that were amenable to chlorinated pesticide cleanup were detected. No serious attempts were made to quantitate metabolites or oxygen analogs of the organophosphates.

The columns used for phosphate analyses were identical to those described for the chlorinated pesticides complex.

3. Arsenic Analysis. Arsenic was detected by atomic absorption following (a) hydrochloric acid extraction, (b) reduction to the plus three valence form, (c) partitioning into benzene, and (d) back partitioning into water. The initial analyses, however, were done by a modified colorimetric method (4).

4. 2,4-D Analysis. The analysis of 2,4-D was done using the method described by Woodham, et al. in 1967 (5).

5. Confirmation Techniques. In addition to dual-column gas chromatographic confirmations, the following techniques were also used to verify questionable results: Thin-layer chromatography; combined TLC-GLC; p-value comparisons; sulfonations; nitrations; oxidations; saponifications; and special column cleanup procedures.

E. Discussion of Analytical Methodology

It should be reiterated that during the pilot studies herein reported, analytical methodology was constantly being improved. At the outset, arbitrary methods were adopted that incorporated empirical compromise between quality and quantity. This was necessary because of the large volume of samples that had to be analyzed. As the program proceeded, many changes were made in cleanup procedures, instrumentation, and analytical methods.

The methods reported in the literature (particularly the FDA Pesticide Analytical Manual) (3) were very helpful. Many methods, however, were adaptable to small numbers of samples, but presented major problems in handling large numbers of samples. Each new pesticide class also offered its own peculiar problems in the scaled-up operation.

Important advances were made during the study in improved cleanup techniques, improved analytical methods, quality control, and placing sample analysis on a production scale.

EXPLANATION OF TABLES

Soil

Pesticide residues found in soil and the amounts of pesticide applied are listed by block for each pesticide found in each area. The pesticides searched for are listed in table 1. Most are detectable when soil is extracted for chlorinated hydrocarbons. Other pesticides requiring special extraction procedures were 2,4-D; 2,4,5-T; and arsenic.

Crop/Soil

Paired crop and soil data are tabulated by block and crop with entries listed for soil, plant material, and the crop itself. All pesticides detected are included in the same table.

Water/Sediment

Water and sediment sample data are tabulated by category, i.e., contained surface, quick runoff, and irrigation. Samples are listed by date collected for each block or source.

Table 1.--Pesticides analyzed for by gas chromatography analysis: USDA Pesticides Monitoring Laboratory, Gulfport, Miss.

Detectable by electron capture		Detectable by modified hydrogen flame technique	
Group I		Group II	
aldrin	isobenzan	azinphosethyl	fenthion
	isodrin	azinphosmethyl	
BHC			Imidan*
binapacryl	lindane	carbophenothion	
Bulan*		coumaphos	malathion
	methoxychlor		Merphos* (Folex*)
CDEC	mirex	DEF*	methyl demeton
chlordane	Morestan*	demeton	methyl parathion
		diazinon	Methyl Trithion*
2,4-D	ovex	dichlorvos	
DDE isomers		dimethoate	oxydemetonmethyl
DDT isomers	PCNB		
dieldrin	Perthane*	ethion	phorate
Dilan*	Prolan*	ethyl parathion	ronnel
dinocap	propanil		
endosulfan	Strobane*		
endrin	sulfur		
EPN			
	2,4,5-T		
Genite 923*	TDE isomers		
	tetradifon		
heptachlor	toxaphene		
hydroxy-chlordene	trifluralin		

*Registered trade names.

Aquatic/Terrestrial Organisms

Residue data for organisms are listed by species and date collected. All pesticides detected are shown in the same table. It should be understood, in reviewing the tables of this report, that years shown are sampling years. For the most part, they represent calendar years; however, some overlapping into the succeeding year did occur in certain study areas.

RESULTS AND DISCUSSION

I. AREA CHA

A. General Description

Area CHA is located near Crystal Springs, Miss., in an area that once supported a large acreage of truck crops. This type of production, however, has been greatly reduced in recent years. The farm on which CHA is located is one of the most productive in the area. Cotton is the principal crop, but soybeans, corn, and some vegetables are also grown. The fields (blocks) are interspersed with pastures, and about 100 acres of CHA are covered by woodland or wildlife area. The study area contains two permanent ponds, and a creek runs along the north side (figure 1).

Weather data for CHA are presented in table 2.

B. Soil Description

The upland soils have gray-brown silt-loam layers with yellow-brown, heavy silt loam or silty clay-loam upper subsoils. Most of these soils have a very dense mottled layer (fragipan) at depths of 1 1/2 to 2 1/2 feet. Fragipan is very slowly permeable to water, and most plant roots do not penetrate that layer. CHA soils are low to medium in plant nutrients and are acid throughout, requiring liming.

C. Soil Analysis

Pesticide residues found in soils from CHA generally reflect pesticide use. The pesticides detected were the DDT complex, dieldrin, endrin, toxaphene/Strobane, and trifluralin. Applications of ethyl parathion, methyl parathion, and 2,4-D were recorded, but those chemicals were not found in soil.

The following pesticides were used at Area CHA:

Before 1965	1965	1966
BHC*	BHC*	2,4-D*
carbaryl	captan	DDT*
DDT*	carbaryl	DEF*
dieldrin*	DDT*	Demosan
endrin*	DEF*	diuron
ethyl parathion*	ethyl parathion*	endrin*
malathion*	methyl parathion*	malathion*
methyl parathion*	mevinphos	methyl parathion*
sulfur*	toxaphene/Strobane*	MSMA*
toxaphene/Strobane*		Panogen
		prometryne
		toxaphene/Strobane*
		trifluralin*

*Analyzed for.

Figure 1--Outline map: Area CHA

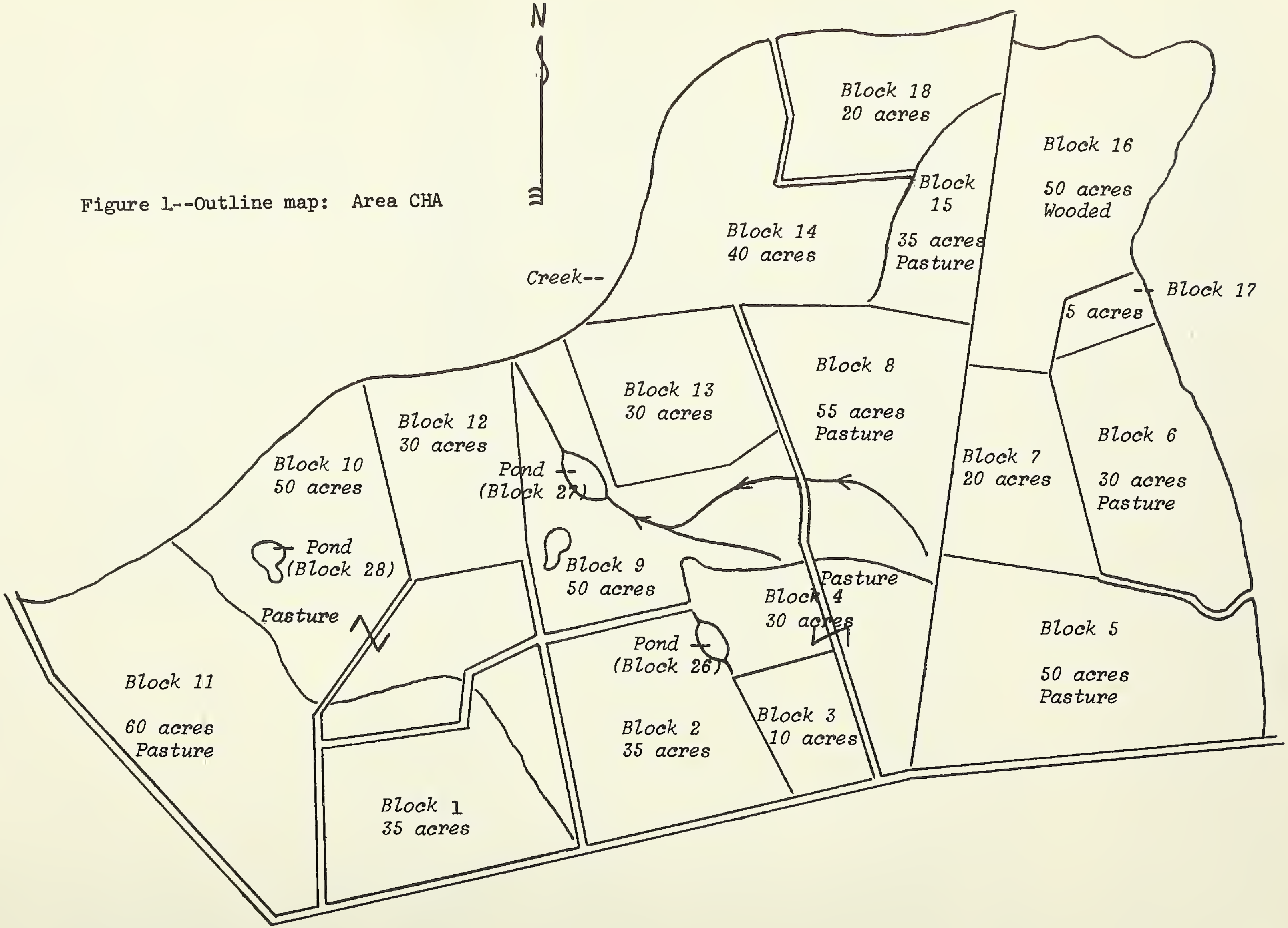

Figure 1--Outline map: Area CHA

Table 2.--Weather Data: Area CHA

Year and month	Temperature		Relative humidity		Total rainfall
	Minimum	Maximum	Minimum	Maximum	
	°F.	°F.	Pct.	Pct.	In.
1965:					
March............	24	88	16	92	3.35
April............	41	92	20	90	.19+
May..............	46	93	22	90	.95
June.............	60	99	22	90	.66+
July.............	64	98	45	100	2.13+
Aug..............	60	97	40	100	2.72+
Sept.............	47	96	33	100	3.75
Oct..............	30	88	24	100	1.20+
Nov..............	26	84	20	100	2.01+
Dec..............	18	76	20	100	3.43+
1966:					
Jan..............	13	74	27	100	9.14+
Feb..............	22	74	27	100	7.39
March............	25	85	20	100	1.14+
April............	36	88	20	100	8.44+
May..............	49	91	32	100	3.55+
June.............	48	97	30	100	.59+
July.............	66	101	31	100	4.31+
Aug..............	54	96	35	100	3.20+
Sept.............	52	94	31	100	4.55+
Oct..............	32	89	25	100	1.84
Nov..............	19	81	21	100	3.70+
Dec..............	14	78	27	100	3.98

Any of the pesticides listed here but not shown in the residue tables were not analyzed for or not detected.

DDT was used on a total of nine blocks at CHA. The average[4] amounts applied were 11.953 lb/A before 1965, 0.276 lb/A in 1965, and 0.285 lb/A in 1966.

DDT residues in soil (table 3) decreased slightly from spring to fall each year and decreased from 1965 to 1966. There appeared to be a decline in the DDT level with time, even though the average amount applied in 1966 was more than in 1965. (It was used on eight blocks in 1965 and six in 1966.)

Dieldrin was used on only one field (before 1965) and was recovered from only that field (table 4). It is interesting to note that the residue was not picked up until the spring of 1966.

The use of endrin at CHA was restricted to four blocks. Endrin was not used after 1964. Residues of endrin were found in two of the four fields and in one field with no record of endrin use (table 5). No residues of endrin were detected in soil after the spring of 1965, indicating a fairly rapid dissipation of endrin in that area.

The treatment record for CHA indicates a heavy use of toxaphene and/or Strobane on seven blocks before 1965 and continued use through 1966 (table 6). As noted on the table, early analyses for toxaphene/Strobane were done by colorimetry. The data for 1965 and the spring of 1966 are useful only for comparison with each other. The fall 1966 data, on the other hand, resulted from analysis by gas chromatography.

[4] Weighted on the basis of block acreages.

Table 3.--Combined DDT residues in soil: Area CHA

NOTE: Empty space indicates no residues detected.

Block	Acres	Amount applied before 1965	1965			1966		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m	Lb./acre	P.p.m.
1.......	35	63.25	3.24	0	3.94	3.01	0.45	3.67
2.......	40	63.25	2.82	0.50	3.64	4.01	.64	2.80
3.......	50	63.25	4.92	1.60	6.78	5.18	.84	5.51
4.......	55	0	1.91	0	1.92	.30	0	.53
5.......	25	21.95	2.35	0	2.14	1.28	0	2.01
6.......	60	0	1.80	0	1.69	1.38	0	1.17
7.......	20	1.50	.26	1.20	.70	.51	1.27	.94
8.......	40	0		0	.16	.11	0	.16
9.......	47	0	.25	0	.40	.19	0	.26
10.......	35	0	2.35	0	1.86	.89	0	1.45
11.......	30	0	.18	0	.42	.10	0	.30
12.......	25	14.50	2.24	0	2.48	2.28	.51	3.08
13.......	15	24.35	2.49	.50	2.68	2.81	.51	3.67
14.......	10	24.35	2.15	.50	2.77	2.18	.70	2.24
15.......	9	0	.03	0	.03	.04	0	.01
16.......	12	0	.10	0	.50	.06	0	.43
17.......	15	0	.79	0	.59	.67	0	.50
18.......	35	24.35	6.38	.50	4.60	3.15	.70	3.49
Acreage-weighted averages:		18.474	2.151	0.276	2.340	1.650	0.288	1.885

Table 4.--Dieldrin residues in soil: Area CHA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1........	35	0		0			0	
2........	40	0		0			0	
3........	50	0		0			0	
4........	55	0		0			0	
5........	25	0.37		0		0.02	0	
6........	60	0		0			0	
7........	20	0		0			0	
8........	40	0		0			0	
9........	47	0		0			0	
10........	35	0		0			0	
11........	30	0		0			0	
12........	25	0		0			0	
13........	15	0		0			0	
14........	10	0		0			0	
15........	9	0		0			0	
16........	12	0		0			0	
17........	15	0		0			0	
18........	35	0		0			0	
Acreage-weighted averages:		0.017		0		0.001	0	

Table 5.--Endrin residues in soil: Area CHA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965 Spring	1965 Amount applied	1965 Fall	1966 Spring	1966 Amount applied	1966 Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1........	35	0.50	0.15	0			0	
2........	40	.50	.16	0			0	
3........	50	.50		0			0	
4........	55	0		0			0	
5........	25	0		0			0	
6........	60	0		0			0	
7........	20	0		0			0	
8........	40	0		0			0	
9........	47	0		0			0	
10........	35	0		0			0	
11........	30	0		0			0	
12........	25	1.00		0			0	
13........	15	0		0			0	
14........	10	0	.09	0			0	
15........	9	0		0			0	
16........	12	0		0			0	
17........	15	0		0			0	
18........	35	0		0			0	
Acreage-weighted averages:		0.157	0.023	0			0	

Table 6.--Toxaphene/Strobane residues in soil: Area CHA

NOTE: Empty spaces indicate no residues detected and dashes indicate no information available.

Block	Acres	Amount applied before 1965	1965[1] Spring	1965[1] Amount applied	1965[1] Fall	1966 Spring[1]	1966 Amount applied	1966 Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.........	35	61.80		0			0.88	2.94
2.........	40	61.80		1.00			1.30	1.84
3.........	50	61.80		0			1.69	2.18
4.........	55	0		0			0	.56
5.........	25	3.88		0			0	.64
6.........	60	0		0			0	.57
7.........	20	3.60		2.40			2.53	.93
8.........	40	0		0			0	
9.........	47	0		0			0	.16
10.........	35	0		0			4.00	.62
11.........	30	0		0			0	
12.........	25	28.00		0			1.03	1.71
13.........	15	41.50		1.00			.89	1.15
14.........	10	41.50		1.00			1.41	1.08
15.........	9	0		0			0	
16.........	12	0		0			0	
17.........	15	0		0			0	
18.........	35	41.50		1.00			1.41	2.12
Acreage-weighted averages:		19.864		0.265			0.825	1.002

[1] Results unreportable because of sulfur interference.

Table 7.--Trifluralin residues in soil: Area CHA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m	Lb./acre	P.p.m.
1.........	35	0		0		0.30[1]	0.43	0.08
2.........	40	0		0			.50	.05
3.........	50	0		0			0	
4.........	55	0		0			0	
5.........	25	0		0			0	
6.........	60	0		0			0	
7.........	20	0		0			.48	.08
8.........	40	0		0			0	
9.........	47	0		0			0	
10.........	35	0		0			0	
11.........	30	0		0			0	
12.........	25	0		0			.50	.03
13.........	15	0		0			.50	.09
14.........	10	0		0			.50	.05
15.........	9	0		0			0	
16.........	12	0		0			0	
17.........	15	0		0			0	
18.........	35	0		0			.50	.05
Acreage-weighted averages:		0		0		0.019	0.156	0.019

[1] Application 1 week before sampling.

The average residue per block in the fall of 1966 (weighed by block acreages) was only slightly above 1 p.p.m. in spite of repeated use of toxaphene/Strobane.

Trifluralin was used in 1966 at CHA on seven blocks. Recoveries of that chemical from soil were restricted to the fall samples of 1966, with the exception of one relatively large residue in the spring (table 7). As noted in table 7, the 1966 application on block 1 was made 1 week before the spring samples were taken, thus explaining the high residue mentioned above.

D. Paired Crop and Soil Analyses

The pairing of crop and soil samples was intended to give a comparison of pesticide residues found in the soil with those found in the crop but foliage applications made this comparison impossible. Another factor that could affect residues found in the crop was drift from pesticide applications in adjacent fields.

The crops sampled at CHA were cabbage, corn, cotton, grass, and peas (table 8). DDT was found in every crop, but only in one crop sample. Relatively large amounts of DDT were found in the companion soil samples. Dieldrin was detected in cotton plants and cottonseed but not in the soil, suggesting the residues were due to drift from another field.

Although the pastures at CHA were not treated with pesticides in 1965 or 1966, DDT was found in all but one sample of pasture grass (table 9). There appears to be an accumulation of DDT in pasture grass as the season progresses, as evidenced by the 1965 and 1966 data for block 8. Small amounts of dieldrin were found in about one third of the grass samples, but endrin was found in only three, at relatively low levels. Methyl parathion was found in both 1966 samples.

Table 8.--Pesticide residues in paired crop and soil samples in 1965 and 1966: Area CHA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available

Year and crop	Block	Amount applied							
		DDT	Parathion	Methyl parathion	Toxaphene/ Strobane	BHC	Carbaryl	Malathion	Diuron
1965		Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre
Cabbage....	3	1.60	0.20			0.48	1.10		
Grass......	10								
Corn.......	17								
Peas.......	18								
(Pods)...		--	--	--	--	--	--	--	--
Cotton.....	18	.50		4.56	1.00				
1966									
Peas.......	3							2.50	
Cotton.....	3	.64		3.30	1.69				0.21

Year and crop	Block	Soil analyses			Crop plant analyses				Crop analyses
		DDT	Toxaphene	Lindane	DDT	Dieldrin	DEF	Methyl parathion	DDT
1965		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Cabbage....	3	6.00			--	--	--	--	0.04
Grass......	10	.25			0.13				--
Corn.......	17	.49			.18				.02
Peas.......	18	3.74			.08				
(Pods)...		--	--	--	.01				--
Cotton.....	18	3.47			.99	0.02			
1966									
Peas.......	3	5.18	--[1]		.18				
Cotton.....	3	5.46	1.72	0.05	3.94		0.86	0.03	

[1] Unreportable because of sulfur interference.

E. Water and Sediment Analyses

Two ponds receiving drainage from within Area CHA were sampled as blocks 27 and 28 (figure 1). Block 26 received drainage from without as well as within the area. Water and sediment data are tabled as contained surface water and sediment in tables 10, 11, and 12.

Pesticide residues found in water and sediment from block 26 (table 10) were primarily of the DDT complex (DDT, TDE, and DDE) but a few scattered water samples contained small amounts of dieldrin, endrin, lindane, trifluralin, and 2,4-D. Residues of these pesticides were all less than 0.01 p.p.m.

All of the sediment samples from block 26 contained TDE and DDE in amounts generally less than 1 p.p.m. Five of the sediment samples did, however, contain more than 1 p.p.m. of TDE. All but six of the sediment samples contained DDT (less than 1 p.p.m.).

Residues found in water from block 26 were all very small (only five were above 1 p.p.b.). TDE was found in more samples than any other chemical. In fact, the DDT complex was the most frequently detected in water from block 26. Other chemicals found were dieldrin (2 samples), endrin (4 samples), lindane (3 samples), trifluralin (4 samples), and 2,4-D (2 samples).

Table 9.--Pesticide residues in pasture grass in 1965 and 1966: Area CHA

NOTE: Empty spaces indicate no residues detected.

Year and Block	Sampling date	DDT	Dieldrin	Endrin	Methyl parathion
1965		P.p.m.	P.p.m.	P.p.m.	P.p.m.
4	May 26	0.26	0.01		
5	June 17	.30			
6	June 17	.04			
6	July 6	.28	.01		
6	Aug. 10	.37		0.03	
8	May 26	.27	.01		
8	June 24	.25			
8	Aug. 4	.34			
8	Sept. 7	.80	.03		
8	Oct. 1	.22			
8	Oct. 22	.22			
9	June 3	.03			
10	June 3	.11			
11	June 16	.03			
15	June 1	.07			
1966					
8	May 20				
8	June 20	.06			
8	Aug. 5	.44	.03		0.09
8	Sept. 7	.75	.08		.01

Water and sediment from block 27 present a different residue picture (table 11). By far the most frequently detected chemicals were TDE and DDE in sediment. DDT and TDE were found in one water sample each at well below the 1 p.p.b. level. Other pesticides found in water were lindane (1 sample), trifluralin (2 samples), and 2,4-D (1 sample).

Water and sediment from block 28 were the most pesticide-free of the three ponds sampled at CHA (table 12). TDE and DDE were found in sediment; lindane and trifluralin were found in water. Only six samples out of 70 had residues of any kind. Block 28 did not receive any drainage from outside of block 10 during the study. The differences observed between ponds at CHA can be partly accounted for by the fact that blocks 27 and 28 (where the fewest residues were detected) are situated within pastures, whereas block 26 is on the edge of a cotton field.

Residues detected in quick runoff water (table 13) again indicate that water entering block 26 most often contained residues. With few exceptions, the levels detected in runoff water were below 1 p.p.b.

Members of the DDT complex were the most commonly detected. Dieldrin was found in two samples, and endrin was found in seven. Other pesticides found in quick runoff water were lindane (2 samples) and trifluralin (5 samples).

Only four samples of irrigation water were collected at CHA (table 14). Three of the samples contained DDT and TDE, and one sample contained DDE. It should be noted that residues in irrigation water were larger than 1 p.p.b. for the most part. Apparently, more of the chemicals were picked up from the soil surface by irrigation water than by the quick-runoff water from rainfall.

Table 10.--Pesticide residues in contained surface water and sediment in 1965, 1966, and 1967: Block 26, Area CHA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Sampling date	Rainfall[1]	DDT		TDE		DDE		Dieldrin		Endrin		Lindane		Trifluralin		2,4-D	
		Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment
1965	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
May 19......			0.36		0.74		0.18										
June 2......		--	.67	--	.95	--	.27	--		--		--		--		--	
June 14.....	0.35		.22		.56		.35										
July 14.....			.22		.69		.30					0.00004					
July 28.....	.14+	0.00080	.22	0.00054	1.19	0.00013	.56			0.00022				0.00150			
Aug. 11.....			.13	.00058	.79		.34			.00023				.00070			
Aug. 25 & 26	.85+		.09	.00066	.67		.15			.00016							
Sept. 13....			.08	.00022	.85	.00008	.25	0.00008									
Sept. 22....	.15			.00008	.87		.22										
Oct. 7......	.70				.64		.16										
Oct. 18 & 20					.37		.08										
Nov. 3......				.00008	.73		.18										
Nov. 17.....			.23	.00019	1.19		.30										
Dec. 13.....				.00015	.47		.12										
1966																	
Jan. 17.....	.02	.00008	.06		.69		.27										
Feb. 14.....	2.38		.12		.74		.27										
Mar. 14.....	.48+		.31		.77		.29										
Apr. 15.....	.56		.17	.00004	1.04		.24										
Apr. 29.....	.74		.16	.00008	.55		.13										
May 13......	.22		.51	.00018	.62		.17										
May 27......			.30	.00021	.68		.16										
June 10.....			.12	.00014	.51		.16										
June 24.....	Trace[2]		.08	.00019	.56	.00004	.21										
July 8......			.08		.73		.24										
July 22.....			.10	.00154	.70		.25										
Aug. 8......			.19	.00021	.35		.22										
Aug. 19.....			.26	.00040	1.08	.00005	.22			.00009							
Sept. 2.....	.02+		.22		.75		.21										
Sept. 16....			.13	.00073	.73	.00010	.24										
Sept. 30....			.17	.00008	1.76	.00008	.27										
Oct. 28.....			.05		.65		.26	.00013									
Nov. 28.....	.65				.76		.27									0.00142	
Dec. 23.....	.14		.06		.64		.25									.00121	
1967																	
Jan. 31.....	--	.00005	.19	.00005	.47	.00003	.24					.00002		.00004			
Feb. 27.....	--		.12	.00003	.46	.00002	.23					.00001		.00001			

[1] Rainfall listed was recorded on the sampling date, one day before, or both.
[2] Less than 0.01 inch.

Table 11.--Pesticide residues in contained surface water and sediment in 1965, 1966, and 1967: Block 27, Area CHA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Sampling date	Rainfall[1]	DDT		TDE		DDE		Lindane		Trifluralin		2,4-D	
		Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment
1965	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
May 27........													
June 7........	0.16+				0.19		0.08						
June 15.......	.46				.26		.09						
June 21.......			0.05		.26		.06						
July 8........	.02				.25			0.00050					
July 19.......					.43		.14						
Aug. 2........	Trace[2]				.20		.11			0.00008			
Aug. 16.......		0.00008			.22		.09			.00011			
Aug. 30.......					.23		.09						
Sept. 13......					.27		.08						
Sept. 29......					.26		.07						
Oct. 11.......													
Oct. 25.......													
Nov. 9........	Trace[2]				.21		.07						
Dec. 13.......					.26		.07						
1966													
Jan. 17.......	.02				.08								
Feb. 14.......	2.38												
Mar. 14.......	.48+				.11								
Apr. 15.......	.56				.13		.04						
Apr. 29.......	.74			0.00020	.10		.03						
May 13........	.22				.14		.04						
May 27........					.15		.04						
June 10.......					.12								
June 24.......	Trace[2]				.27		.06						
July 8........					.17								
July 22.......					.16		.07						
Aug. 8........					.08		.06						
Aug. 19.......					.38		.11						
Sept. 2.......	.02+				.26		.09						
Sept. 16......					.30		.13						
Sept. 30......					.72		.11						
Oct. 28.......					.30		.09						
Nov. 28.......	.65				.35		.11					0.00161	
Dec. 23.......	.14				.16		.10						
1967													
Jan. 31.......	--				.15		.05						
Feb. 27.......	--				.09		.03						

[1] Rainfall listed was recorded on the sampling date, one day before, or both.
[2] Less than 0.01 inch.

Table 12.--Pesticide residues in contained surface water and sediment in 1965, 1966, and 1967: Block 28, Area CHA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Sampling date	Rainfall[1]	TDE		DDE		Lindane	
		Water	Sediment	Water	Sediment	Water	Sediment
1965	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
May 18...........			0.08				
June 2...........			.13		0.05		
June 21...........			.05				
July 12...........	0.20		.14			0.00017	
July 26...........	.01		.14		.04		
Aug. 9...........	.02						
Aug. 23...........	.85+						
Sept. 8...........							
Sept. 20..........	.05						
Oct. 4...........							
Oct. 18...........							
Nov. 1...........							
Nov. 12 & 15......	.06						
Dec. 13...........							
1966							
Jan. 17...........	.02						
Feb. 14...........	2.38						
Mar. 14...........	.48+						
Apr. 15...........	.56						
Apr. 29...........	.74						
May 13...........	.22						
May 27...........							
June 10...........							
June 24...........	Trace[2]					.00014	
July 8...........							
July 22...........							
Aug. 8...........							
Aug. 19...........							
Sept. 2...........	.02+						
Sept. 16..........							
Sept. 30..........							
Oct. 28...........							
Nov. 28...........	.65						
Dec. 23...........	.14						
1967							
Jan. 31...........	--						
Feb. 27...........	--						

[1] Rainfall listed was recorded on the sampling date, one day before, or both.
[2] Less than 0.01 inch.

F. Aquatic and Terrestrial Organism Analyses

The aquatic organisms collected and analyzed were primarily fish and turtles, but included crayfish, tadpoles, and algae. All collections of aquatics were made from the three ponds designated as blocks 26, 27, and 28, from which water and sediment samples were taken.

Only turtles, crayfish, tadpoles, and algae were taken from block 26 (table 15). The DDT complex was found in turtles; TDE and DDE were found in crayfish and tadpoles, and the whole DDT complex was found in algae. In turtles and crayfish, the largest residues were of DDE, but in tadpoles and algae more TDE was found.

Table 13.--Pesticide residues in quick runoff water in 1965, 1966, and 1967: Area CHA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Sampling date	Block	Rainfall	DDT	TDE	DDE	Dieldrin	Endrin	Lindane	Trifluralin
1965		In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
June 25	26	--			0.00008			0.00017	
	27								
	28								
Aug. 7	26	0.62					0.00018		0.00220
	27								.00015
	28								.00008
Sept. 10	26	1.49		0.00012			.00008		
	27			.00008			.00008		
	28								
Nov. 5	26	1.35		.00025					
	27			.00011		0.00040			
	28								
1966									
Jan. 13	26	1.16							
	27								
	28								
Feb. 10	26	2.00					.00008		
	27								
	28								
Apr. 21	26	3.88		.00008	.00002				
	27			.00025	.00008				
	28								
Apr. 26	26	.91							
	27			.00012					
	28								
May 18	26	.60	0.00016	.00009	.00005				
	27		.00082	.00017			.00018		
	28								
Aug. 10	26	.67		.00059	.00008		.00037		
	27			.00411	.00071		.00038		
	28								
Oct. 18	26	.92							
	27								
	28								
1967									
Feb. 20	26	--	.00009	.00001	.00003			.00001	.00016
	27								

With the exception of four turtle samples each, in 1965 and 1966, all of the samples from block 27 were fish, with seven species represented (table 16). The only pesticides found in the fish and turtles were of the DDT complex, with the exception of one turtle sample that contained dieldrin. Residues detected in fish were definitely larger than those detected in turtles. There appeared to be little difference among species in the amounts of pesticides stored.

The samples collected from block 28 were again primarily fish, with a few turtle samples and one crayfish sample (table 17). Chemicals of the DDT complex were the most prevalent, but dieldrin was found in about one third of the samples, and a small amount of endrin was detected in one fish sample. At least one member of the DDT family was found in every sample from block 28, but the levels found were lower than those found in samples from blocks 26 and 27.

Table 14.--Pesticide residues in irrigation water in May 1965: Block 3, Area CHA

NOTE: Empty spaces indicate no residues detected.

Sampling Date	DDT	TDE	DDE
	P.p.m.	P.p.m.	P.p.m.
May 10..........................	0.00115	0.00065	0.00016
May 11..........................	.00958	.00953	
May 20..........................			
May 21..........................	.01318	.00324	

Table 15.--Pesticide residues in aquatic organisms: Block 26, Area CHA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Organisms	1965 sampling season				1966 sampling season			
	Date of Sampling	DDT	TDE	DDE	Date of Sampling	DDT	TDE	DDE
		P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.
Pseudemys scripta elegans........ (red-eared turtle)	May 25..........	0.46	0.20	8.48	--	--	--	--
Crayfish...........................	June 29 & July 1		.75	2.58	--	--	--	--
Tadpoles.........................	Sept. 3.........		6.74	2.19	--	--	--	--
Algae.............................	Sept. 3.........		3.80	1.10	Feb. 1..........	0.19	0.17	0.40

Table 16.--Pesticide residues found in aquatic organisms: Block 27, Area CHA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Organisms	1965 sampling season					1966 sampling season			
	Date of sampling	DDT	TDE	DDE	Dieldrin	Date of sampling	DDT	TDE	DDE
		P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.
Lepomis macrochirus....... (Blue gill)	June 30...........	1.09	0.90	2.80		Aug. 18 to Aug. 24.	1.64	4.18	2.47
	Aug. 2 to Aug. 6...	.02	.81	2.76		--	--	--	--
	Sept. 3...........	.26	1.01	1.56		--	--	--	--
	Sept. 30 & Oct. 4..	1.95	1.34	1.23		--	--	--	--
	Nov. 2 & Nov. 3....	.47	1.38	1.29		--	--	--	--
L. cyanellus............. (Green sunfish)	--	--	--	--	--	Aug. 18 to Aug. 24.	.25	4.25	1.85
Darsoma cepedianum........ (gizzard shad)	Aug. 2............	2.67	3.07	4.29		--	--	--	--
	Sept. 1............	1.09	4.68	1.88		--	--	--	--
	Oct. 4............	.73	3.87	2.09		--	--	--	--
	Nov. 3............	1.07	5.78	3.09		--	--	--	--
Gambusia affinis.......... (Gambusia)	Aug. 2............	.77	.75	1.88		Aug. 18 to Aug. 23.	1.13	2.82	1.12
	Sept. 3............	.19	.67	1.23		Sept. 29 to Oct. 3.	.78	1.41	.92
	Oct. 4............	.11	.62	1.29		Nov. 21...........	.10	2.62	1.87
	Nov. 3............	.26	.56	1.22		--	--	--	--
Notemigonus crysoleucas... (golden shiner)	Aug. 2............	.90	2.55	5.08		July 21 to Aug. 6..	.33	4.52	2.65
	Aug. 30...........		1.89	2.95		Aug. 18 to Aug. 23.	.34	5.26	2.07
	Oct. 4............		.60	1.08		Sept. 29 to Oct. 4.	2.77	6.00	2.82
	Nov. 3............		.70	1.70		Nov. 21...........	2.74	1.75	1.63
Chaenobryttus spp......... (Warmouth)	Aug. 2 to Aug. 6...	.77	1.26	3.20		July 21 to Aug. 7..	.99	2.52	1.06
	Sept. 2...........	.20	.97	.82		Aug. 18 to Aug. 19.	.58	1.94	.85
	Sept. 30 & Oct. 1..	.40	1.52	1.56		--	--	--	--
	Nov. 2 & Nov. 3....	.31	1.93	1.59		--	--	--	--
Ictalurus nebulosus....... (brown bullhead)	Aug. 2............	1.52	3.89	3.47		July 21 to Aug. 1...	1.13	3.69	1.48
	Sept. 2...........	.29	2.14	1.21		Aug. 18 to Aug. 23.	.90	2.85	1.42
	Sept. 30..........	.16	1.34	.81		--	--	--	--
	Nov. 2............	.16	.93	.61		--	--	--	--
Pseudemys scripta elegans. (red-eared turtle)	June 30...........	.02		.28		Apr. 22 to Apr. 25.	.08	.02	1.16
	Aug. 2............	.06	.05	1.40	0.03	July 29 to Aug. 2..	.10		.78
	Sept. 2 & Sept. 4..			.14		--	--	--	--
	Oct. 7 & Oct. 8....	.31		.86		--	--	--	--
Kinosternon s. subrubrum.. (Eastern mud turtle)	--	--	--	--	--	Apr. 25 to June 3..	.19	.06	.56
	--	--	--	--	--	Aug. 2 to Aug. 3...	.44	.03	.76

Table 17.--Pesticide residues found in aquatic organisms: Block 28, CHA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Organisms	1965 sampling season					1966 sampling season					
	Date of sampling	DDT	TDE	DDE	Dieldrin	Date of sampling	DDT	TDE	DDE	Dieldrin	Endrin
		P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Lepomis macrochirus..... (blue gill)	May 25, 1965...........	0.42	0.62	1.02		Apr. 12 to Apr. 19, 1966..	0.11	0.86	0.43		
	June 29, 1965..........	.26	.83	.88		May 16 to May 31, 1966....	.15	.42	.37		
	July 30 to July 31, 1965	.43	.84	1.19		June 17 to June 21, 1966..		.30	.29		
	Aug. 30 to Aug. 31, 1965	.05	.34	.15		July 18 to July 27, 1966..		.29	.23		
	Sept. 30 & Oct. 1, 1965.	.07	.49	.23		Aug. 18 to Aug. 31, 1966..	.04	.23	.10	0.02	
	Oct. 29 & Nov. 4, 1965..	.07	.34	.19		Sept. 27 to Oct. 28, 1966.	.04	1.12	.08		
	Feb. 14 to Feb. 17, 1966		.27	.27		--	--	--	--	--	--
L. cyanellus........... (green sunfish)	July 30, 1965..........	.24	.54	1.21		Apr. 11 to Apr. 13, 1966..		.08	.08		
	Aug. 30, 1965..........	.05	.32	.19		May 16 to May 19, 1966....		.25	.13		
	Oct. 4, 1965...........	.03	.15	.15		June 17 to June 21, 1966..	.33		.46		
	Oct. 29 & Nov. 1, 1965..		.26	.23		July 18, 1966............		.78	.33		
	Feb. 14 to Feb. 17, 1966			.10		Aug. 16, 1966............	.02	.11	.03		
	--	--	--	--	--	Sept. 26, 1966...........	.05	.97	.08	.01	
	--	--	--	--	--	Oct. 19 to Oct. 24, 1966..	.03	.60	.08	.01	
	--	--	--	--	--	Nov. 21, 1966............	.10	4.26	.58	.04	
	--	--	--	--	--	Jan. 5 to Jan 6, 1967.....	.04	.59	.20		
Darsoma cepedianum...... (gizzard shad)	June 29 & July 1, 1965..	.19	.70	.41		Apr. 13 to Apr. 19, 1966..		.36	.15		
	July 30, 1965..........	.21	.69	.41	0.09	May 25, 1966.............		.32	.09		
	Aug. 30 & Sept. 1, 1965.	.18	.36	.35		June 22, 1966............		.88	.34		
	Oct. 4, 1965...........	.08	1.78	.34		July 20, 1966............		.73	.21		
	Nov. 1, 1965...........	.12	1.67	.53		Aug. 17 to Aug. 18, 1966..		.17	.06		
	--	--	--	--	--	Sept. 28, 1966...........	.24	4.35	.27	.02	0.09
	--	--	--	--	--	Oct. 28, 1966............	.10	2.86	.19	.05	
	--	--	--	--	--	Nov. 21, 1966............	.29	4.85	1.28	.13	
Gambusia affinis........ (Gambusia)	July 30, 1965..........	.21	.14	.33		Apr. 18, 1966............		.36	.16		
	Aug. 30, 1965..........	.11	.20	.33		May 25, 1966.............		.38	.17		
	Oct. 4, 1965...........		.22	.31		June 22, 1966............	.04	.48	.36		
	Nov. 1, 1965...........		.23	.34		July 20, 1966............		.08	.20		
	--	--	--	--	--	Aug. 17, 1966............	.09	.60	.24	.02	
	--	--	--	--	--	Sept. 28, 1966...........			.06		
	--	--	--	--	--	Oct. 28, 1966............	.06	.55	.08	.01	
	--	--	--	--	--	Nov. 21, 1966............	.07	.58	.10	.01	
Notemigonus crysoleucas. (golden shiner)	June 29 & July 1, 1965..	.13	.74	.98		Apr. 11 to Apr. 18, 1966..		.36	.26		
	July 30, 1965..........	.17	.24	.67		May 25, 1966.............		.37	.16		
	Aug. 30, 1965..........		.78	.81		June 17 to June 22, 1966..		.76	.24		
	Oct. 4, 1965...........		.46	.85		July 18 to July 20, 1966..		.40	.17		
	Nov. 1, 1965...........	.02	.50	.66		Aug. 17, 1966............	.12	1.40	.17	.02	
	--	--	--	--	--	Sept. 28, 1966...........	.07	.49	.25	.01	
	--	--	--	--	--	Oct. 28, 1966............	.09	1.13	.34	.01	
	--	--	--	--	--	Nov. 21, 1966............	.32	7.39	1.29	.05	
	--	--	--	--	--	Jan. 5 to Jan. 27, 1967...	.09	.78	.45		
Chaenobryttus gulosus... (Warmouth)	June 29, 1965..........	.13	.39	.51		Apr. 11 to Apr. 13, 1966..		.19	.24		
	July 30, 1965..........	.19	.48	.82		May 16 to May 25, 1966....		.26	.17		
	Aug. 30, 1965..........	.09	.42	.23		June 22 to July 5, 1966...		.54	.33		
	Sept. 30, 1965.........	.08	.65	.41		July 18 to July 19, 1966..		.54	.30		
	Oct. 29 & Nov. 1, 1965..		.69	.32		Aug. 16 to Aug. 17 1966...	.02	.14	.07		
	Feb. 14 to Feb. 17, 1966		.12	.16		Sept. 26 to Sept. 28, 1966	.03	.68	.08		
	--	--	--	--	--	Nov. 21, 1966............	.04	.99	.24	.01	
	--	--	--	--	--	Jan. 24 to Jan. 25, 1967..	.08	1.51	.42	.02	
Ictalurus nebulosus..... (brown bullhead)	July 30, 1965...........	.15	.31	.69		Apr. 11 to Apr. 14, 1966..		.42	.16		
	Sept. 2, 1965...........	.08	.82	.58		May 16 to May 20, 1966....		.97	.20		
	Sept. 30, 1965..........	.05	.96	.41		June 17 to June 22, 1966..		.76	.27		
	Oct. 29, 1965...........		.72	.24		July 18 to July 19, 1966..		.55	.17		
	Feb. 16 to Mar. 10, 1966.		.92	.89		Aug. 16, 1966............	.05	.21	.08	.01	
	--	--	--	--	--	Sept. 26 to Sept. 27, 1966	.03	.30	.08		
	--	--	--	--	--	Nov. 21, 1966............	.06	1.99	.28	.03	
	--	--	--	--	--	Jan. 5 to Jan 25, 1967....	.12	2.79	.48	.03	
Pseudemys scripta elegans (red-eared turtle)	June 28, 1965...........	.13	.02	1.06		May 10 to June 3, 1966....	.03		.10		
	Aug. 30 & Aug. 31 1965...	.07	.02	.39		July 19 to Aug. 4, 1966...	.03	.01	.08	.01	
	--	--	--	--	--	Oct. 3, 1966.............	.01	.01	.06	.01	
Kinosternon s. subrubrum. (Eastern mud turtle)	July 30 & 31, 1965.......	.36	.24	2.35	.06	Apr. 12 to Apr. 19, 1966..	.04		.31		
	--	--	--	--	--	July 18 to Aug. 18, 1966..	.05	.01	.06	.01	
Crayfish................	June 2, 1965............		.03	.14		--	--	--	--	--	--

Terrestrial organisms sampled at CHA included two species of mice, cotton rats, opossums, chipmunks, squirrels, rabbits, earthworms, and white grubs. Samples of chickens, chicken eggs, and beef fat were also collected (table 18). The pesticides found in these organisms were the DDT complex and dieldrin, with a residue of BHC technical (below 0.5 p.p.m.) in the sample of chicken eggs.

With a few exceptions, residue levels of the members of the DDT complex were below 1 p.p.m. In 1966, however, 5.88 p.p.m. DDT was found in house mice, and an opossum sample bore 4.15 p.p.m. DDT and 4.37 p.p.m. DDE. All but one of the dieldrin residues found were well below 0.5 p.p.m. (one chicken sample contained 1.72 p.p.m.).

Table 18.--Pesticide residues in terrestrial organisms: Area CHA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Organisms	1965 sampling season						1966 sampling season				
	Date of sampling	DDT	TDE	DDE	Dieldrin	BHC (technical)	Date of sampling	DDT	TDE	DDE	Dieldrin
		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.
Peromyscus leucopus.. (white-footed mouse)	Apr. 30 to May 14..	0.25	0.03	0.11	0.05		Apr. 13 to May 5....	0.24	0.02	0.13	0.02
	Sept. 23 to Nov. 30		.01	.14	.03		Aug. 31 to Nov. 18..	.13	.04	.27	
Mus musculus.......... (house mouse)	Apr. 30 to May 14..	.48	.07	.09	.03		Apr. 12 to May 9....	5.88	.94	.35	.12
	Oct. 13 to Nov. 11.	.31	.06	.16			Aug. 31 to Nov. 18..	.44	.11	.16	
Sigmodon hispidus..... (hispid cotton rat)	May 1 to May 13....	.03			.02		Aug. 31 to Nov. 18..	.07	.02	.01	
	Oct. 7 to Dec. 1...	.04		.14			--	--	--	--	--
Didelphis marsupialis. (opossum)	Oct. 22 to Nov. 27.	.87	.05	1.29			Nov. 22 to Nov. 28..	4.15	.24	4.37	
Tamias striatus....... (chipmunk)	Oct. 7 to Nov. 10..			.10			Apr. 12 to Apr. 27..			.01	
	--	--	--	--	--	--	Sept. 8 to Oct. 13..			.02	
Sciurus niger......... (squirrel)	Oct. 7 to Nov. 2...			.03			Sept. 12 to Sept. 29	.02		.01	
Sylvilagus floridanus. (rabbit)	May 27.............						Apr. 21 to June 7...				
	Oct. 8 to Dec. 2...						Sept. 26 to Nov. 28.				
Earthworms............	May 11 to June 22..	.04	.01	.03	.01		--	--	--	--	--
	July 1 to Oct. 12..	.07	.02	.09			--	--	--	--	--
White grubs...........	July 1 to Oct. 12..	.06	.02	.15			May 12 to June 9....	.20	.06	.26	.02
Chickens..............	Dec. 7.............	2.52	.33	1.11	.15		Sept. 20............	2.53	.83	4.05	1.72
Chicken eggs..........	Dec. 7.............	1.32	.01	.91	.09	0.32	--	--	--	--	--
Beef fat..............	Dec. 14............	.28	.07	1.78			Sept. 9.............	1.14	.25	.27	

Table 19.--Pesticide residues in birds (nestlings) and bird eggs: Area CHA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Species	1965 sampling season					1966 sampling season				
	Date of sampling	DDT	TDE	DDE	Dieldrin	Date of sampling	DDT	TDE	DDE	Dieldrin
		P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.
Mimus polyglottus..... (Mockingbird)	July 26 & Aug. 2		0.46			June 22 to Aug. 1	0.75	0.37	6.65	0.06
Eggs............	--	--	--	--	--	June 1...........	.78	.09	17.90	.13
Agelaius phoeniceus... (Red-wing blackbird)	--	--	--	--	--	May 12..........	.07	.05	4.46	.04
Eggs............	--	--	--	--	--	May 10...........	4.58	1.07	10.91	.14
Toxostoma r. rufum.... (Brown thrasher)	--	--	--	--	--	May 25 to June 10	.72	.40	6.54	.22
Eggs............	--	--	--	--	--	June 1...........	4.59	1.41	29.43	.10
Quiscalus quiscula.... (Purple grackle)	--	--	--	--	--	June 7 to June 13	.10	.07	4.70	.41
Eggs............	--	--	--	--	--	May 31...........	.70	.08	23.52	.08
Sturnella magma....... (Eastern meadowlark)	--	--	--	--	--	June 16..........			1.38	

Five species of nestling birds were sampled, and eggs of four of those species were obtained (table 19). The nestlings were from the same hatch but not the same nests as the eggs. The DDT complex and dieldrin were found in these samples. DDT complex residues in bird eggs were much larger than those in nestling birds. None of the dieldrin residues found exceeded 0.50 p.p.m. Residue levels appeared to differ little between species.

II. AREA GRA

A. General Description

Area GRA is located near Greenville, Miss., adjoining the Mississippi River levee. In 1964, more than one half of the area was planted in cotton. Other crops grown were soybeans, small grains, and sorghum. There were also 100 acres of pasture (figure 2).

Of two sloughs at GRA, one was entirely contained within the area. Thus GRA contains a slough in its entirety, which afforded a good location for checking the rate of pesticide movement from treated areas into the slough.

The area has a history of endrin and methyl parathion use on cotton, dating back to 1956. Since that time, each material has been applied an average of 13 times per year. In 1964, carbaryl was used on soybeans for looper control. Also in 1964, one application each of endrin and methyl parathion was put on corn.

No pesticides have been used on the uncultivated area north of GRA, but a survey of pesticide usage on adjoining farms indicates that the use of pesticides on GRA is typical of the community. Weather data for Area GRA are listed in table 20.

Table 20.--Weather data: Area GRA

Year and month	Temperature		Relative humidity		Total rainfall
	Minimum	Maximum	Minimum	Maximum	
1965:	°F.	°F.	Pct.	Pct.	In.
Jan.	20	72	30	100	2.36
Feb.	20	74	28	100	7.29+
March.	23	74	26	100	3.14+
April.	43	86	22	100	2.65
May.	51	90	28	100	4.77+
June.	64	92	28	100	3.03
July.	61	96	36	100	1.66
Aug.	64	97	34	100	18.05
Sept.	46	95	37	100	6.20+
Oct.	34	88	22	100	1.62
Nov.	28	83	20	100	1.50
Dec.	22	72	20	100	1.65+
1966:					
Jan.	8	69	27	100	4.35
Feb.	26	72	28	100	8.62+
March.	28	86	16	100	.31
April.	35	85	20	100	5.16+
May.	46	89	26	100	3.06
June.	51	96	25	100	.55
July.	69	100	38	100	4.07
Aug.	58	96	30	100	5.41
Sept.	52	91	30	100	2.70+
Oct.	36	88	16	100	2.49
Nov.	26	80	16	100	2.50
Dec.	24	78	32	100	5.52
1967:					
Jan.	21	74	28	100	1.82

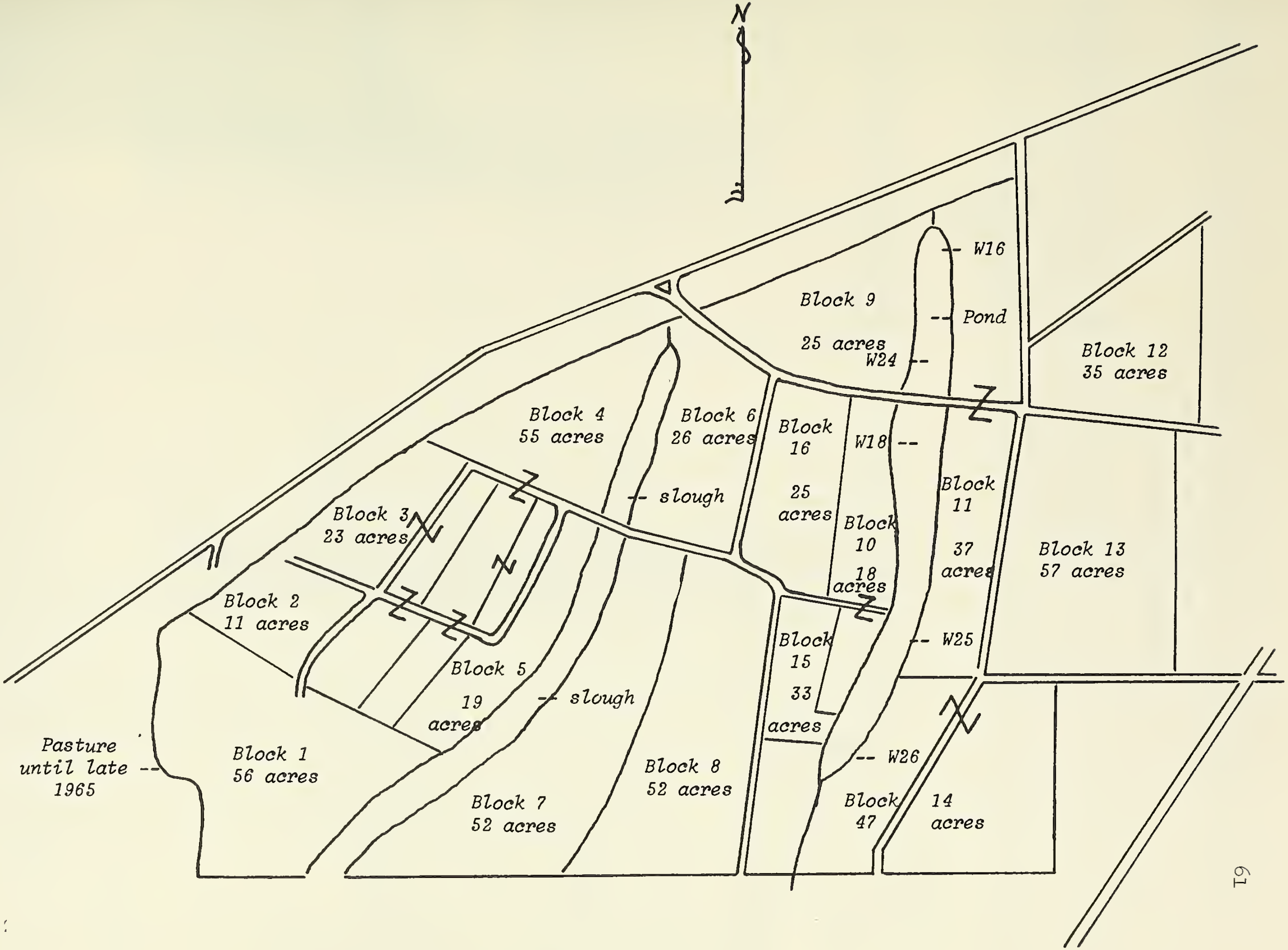

Figure 2.--Outline map: Area GRA

B. Soil Description

The higher lying dominant soils of the gentle convex slopes have medium to moderately fine gray-brown or dark gray-brown surface layers of silt-loam with finer yellow-brown subsoils, commonly mottled with gray in the lower part. The surface layers are acid, with less acid subsoils. These soils are medium to high in plant nutrients and lime.

The dominant soils of the lower lying flats or concave slopes have medium to moderately fine gray-brown surface layers with gray-brown, gray, or yellow-brown mottled subsoils of similar texture. These soils are medium to high in plant nutrients and lime, but require artificial drainage for crop production. Associated with these soils are narrow bands of dark clay on the concave slopes. Light yellow-brown sands on narrow slopes of natural levels are locally conspicuous, minor soils.

C. Soil Analyses

As in Area CHA, pesticide residues in soils from GRA generally reflect pesticide use. Residues of DDT, dieldrin, endrin, toxaphene, and trifluralin were found.

The following pesticides were used at Area GRA:

Before 1965	1965	1966
aldrin*	aldrin*	Bidrin
BHC*	amiben	captan
calcium cyanide	Bidrin	carbaryl
captan	calcium cyanide	dalapon
carbaryl	captan*	2,4-DB
carbophenothion*	carbaryl	DDT*
DDT*	Ceresan	diphenamid
dieldrin*	DDT*	DNBP
diuron	DEF*	endothall
DNBP	dieldrin*	endrin*
endrin*	dioxathion	linuron
malathion*	diuron	malathion*
Merphos*	DSMA	Merphos*
methyl parathion*	endrin*	methyl parathion*
Panogen	malathion*	MSMA*
PCNB*	methyl parathion*	norea
sulfur*	monuron	Panogen
toxaphene*	Panogen	PCNB*
	PCNB*	phorate*
	thiram	sodium chlorate
	toxaphene*	thiram
	trifluralin*	toxaphene*
		trifluralin*

*Analyzed for.

DDT was used on 11 of the 16 blocks of GRA before 1965, on 9 blocks in 1965, and on 8 in 1966. Residues of DDT were found in soil from all 16 blocks but were much smaller in blocks with no record of DDT treatment (table 21). Residue levels in treated fields changed very little from the spring of 1965 to the fall of 1966. In general, fall residues of DDT were slightly higher than spring residues.

Dieldrin was used on 10 fields (blocks) of GRA before 1965, but only on two in 1965 and not at all in 1966. Dieldrin residues were found in soil from all 16 blocks, but they averaged below 0.10 p.p.m. (table 22). Dieldrin residues in soils from GRA declined very slightly during the sampling period, in spite of the fact that practically no dieldrin was used after 1964.

The use of endrin was recorded for 13 of the 16 blocks of GRA before 1965, for 9 blocks in 1965, and for 8 blocks in 1966. In general, the residues of endrin found in soil reflected use (table 23). Throughout the period of study, the residue levels changed very little, in spite of annual treatments on some blocks and not on others.

Table 21.--Combined DDT residues in soil: Area GRA

Block	Acres	Amount applied before 1965	1965			1966		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.........	56	0	0.20	0	0.12	0.14	0	0.21
2.........	11	29.60	6.11	0.67	5.70	6.23	0	5.51
3.........	23	0	1.49	0	2.59	1.71	0	2.54
4.........	55	29.60	3.74	.34	2.71	2.45	0.59	3.18
5.........	19	0	.25	0	.58	.30	0	.67
6.........	26	0	1.16	0	1.39	.48	0	.90
7.........	52	29.51	2.57	.34	3.45	2.46	.72	3.00
8.........	52	29.51	5.25	.34	5.94	4.12	.54	4.29
9.........	25	0	.40	0	.44	.25	0	.61
10.........	18	18.00	4.59	0	3.07	3.16	0	4.40
11.........	37	37.60	6.34	.78	4.98	4.86	.83	5.80
12.........	35	8.00	2.60	0	2.10	1.62	0	1.58
13.........	57	37.60	8.30	2.01	8.11	5.51	.58	6.76
14.........	47	37.60	4.41	1.34	6.03	5.49	.58	5.46
15.........	33	29.51	3.99	.34	4.65	3.21	.28	2.67
16.........	25	29.51	6.12	.34	4.83	4.40	.55	3.61
Acreage-weighted averages:		22.136	3.753	0.504	3.778	2.975	0.371	3.337

Table 22.--Dieldrin residues in soil: Area GRA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1........	56	0		0			0	0.01
2........	11	1.55	0.12	0	0.12	0.11	0	.13
3........	23	0	.06	0	.12	.02	0	.09
4........	55	1.55	.04	0	.02	.04	0	.06
5........	19	0		0		.02	0	.06
6........	26	0	.52	0	.02	.02	0	.04
7........	52	1.55	.04	0	.03	.05	0	.05
8........	52	1.55	.08	0	.09	.03	0	.07
9........	25	0		0.01		.02	0	.01
10........	18	.93	.09	0	.08	.07	0	.04
11........	37	1.55	.07	0	.05	.06	0	.04
12........	35	0	.08	.01	.08	.07	0	.01
13........	57	1.55	.06	0	.10	.09	0	.05
14........	47	1.55	.04	0	.05	.06	0	.10
15........	33	1.55	.06	0	.07	.06	0	.03
16........	25	1.55	.10	0	.03	.10	0	.02
Acreage-weighted averages:		1.031	0.072	0.001	0.051	0.049	0	0.048

Table 23.--Endrin residues in soil: Area GRA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.........	56	0		0			0	0.03
2.........	11	22.33	0.73	1.96	0.83	1.68	0	1.29
3.........	23	2.04		0		.09	0	.16
4.........	55	21.82	.38	1.10	.30	.30	0.84	.56
5.........	19	0		0	.03		0	.05
6.........	26	.07	.23	0	.05		0	.05
7.........	52	21.66	.44	1.03	.35	.33	1.49	.67
8.........	52	21.66	.40	1.03	.45	.41	1.28	.73
9.........	25	0		0	.11	.02	0	.10
10.........	18	14.76	.33	0	.34	.44	0	.61
11.........	37	21.57	.70	.86	.61	.64	1.57	.75
12.........	35	3.77	.18	0	.12		0	.09
13.........	57	21.57	.79	1.57	.81	.51	1.57	.82
14.........	47	21.57	1.14	1.30	.78	.82	1.57	.78
15.........	33	21.66	1.19	1.00	.54	.37	.73	.69
16.........	25	21.66	.70	1.06	.59	.55	1.42	.78
Acreage-weighted averages:		14.785	0.477	0.755	0.386	0.352	0.825	0.517

Table 24.--Toxaphene/Strobane[1] residues in soil: Area GRA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	Amount applied in 1965	1966 Amount applied	Fall
	Number	Lb./acre	Lb./acre	Lb./acre	P.p.m.
1..................	56	0	0	0	
2..................	11	5.25	2.33	0	6.31
3..................	23	0	0	0	1.97
4..................	55	3.25	1.17	1.23	2.52
5..................	19	0	0	0	.38
6..................	26	0	0	0	1.12
7..................	52	4.10	1.17	1.46	2.44
8..................	52	4.10	1.17	1.10	2.82
9..................	25	0	0	0	.59
10..................	18	2.50	0	0	3.31
11..................	37	18.25	2.57	1.64	5.35
12..................	35	14.00	0	0	.43
13..................	57	18.25	5.99	1.17	5.07
14..................	47	18.25	3.66	1.17	4.36
15..................	33	4.10	1.17	.57	2.90
16..................	25	4.10	1.17	1.12	3.26
Acreage-weighted averages:		7.021	1.555	0.753	2.665

[1] All 1965 and spring, 1966 data unreportable because of sulfur interference.

Toxaphene residues found in GRA soils are listed in table 24. Here again, the 1965 and spring 1966 data are unreportable because of sulfur interference in the analysis.

Trifluralin was not used at GRA until 1965, when small amounts were used on five blocks. No residues were found in soil until the fall of that year (table 25). Trifluralin was found in only one block in the spring of 1966. The samples from that block, however, were taken about one

Table 25.--Trifluralin residues in soil: Area GRA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965 Spring	1965 Amount applied	1965 Fall	1966 Spring	1966 Amount applied	1966 Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.........	56	0		0			0	
2.........	11	0		0			0.72	0.16
3.........	23	0		0			0	
4.........	55	0		0.09	0.03		.34	.04
5.........	19	0		0			0	
6.........	26	0		0			0	
7.........	52	0		.35	.13		.32	.09
8.........	52	0		.35	.20		.32	.10
9.........	25	0		0			0	
10.........	18	0		0		[1] 1.23	[2] 1.00	.25
11.........	37	0		0			.32	.07
12.........	35	0		0			0	
13.........	57	0		.75	.09		.32	.13
14.........	47	0		.75	.05		.32	.24
15.........	33	0		0			.32	.12
16.........	25	0		0			.32	.04
Acreage-weighted averages:		0		0.209	0.046	0.039	0.248	0.078

[1] Sample collected 4/12/66.
[2] Applied 3/14/66.

month after trifluralin was applied at 1.0 lb/A. Residues found in the fall 1966 samples were relatively small, the largest being only 0.25 p.p.m. It appears that trifluralin does not persist in soil for any length of time at GRA.

D. Paired Crop and Soil Analyses

The paired crop and soil data from GRA are presented in table 26. In 1965, cotton, oats, wheat, soybeans, and sorghum were collected. Of those crops, only cotton had been treated for pests. All of the soil samples, however, had residues of DDT. The highest level of DDT was found in the cotton field that had been treated with 0.78 lb/A of DDT, but relatively large residues were found in two blocks that were not treated with DDT in 1965.

Analysis of the plant part of the crops sampled in 1965 showed residues of DDT were present in all plant samples but wheat straw. Analysis of the crop itself showed small amounts of DDT in all 1965 samples.

Small amounts of dieldrin were detected in all but one soil sample in 1965. Residues were detected only in the following crop and crop plant samples for that year: Cotton stalks, cottonseed, oats, and straw. The largest dieldrin residue did not exceed 0.10 p.p.m. in soils or 0.03 p.p.m. in crops from GRA (paired samples).

Other pesticides found in some of the 1965 soil samples were endrin, trifluralin, and aldrin. Endrin and toxaphene were also found in a few crop plant samples. The only residue found in the crops themselves, besides DDT and dieldrin, was 0.13 p.p.m. of endrin in sorghum grain.

In 1966, samples of soybeans, wheat, sorghum, and cotton were collected. The bulk of the crop samples were soybeans, including samples of beans taken from combine bins during harvest as part of a special study. Results of the soybean analyses are listed in table 26, but will not be discussed in this report. (2).

Table 26.--Pesticide residues in paired crop and soil samples in 1965 and 1966: Area GRA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Year and crop	Block	Amount applied									Soil analyses			
		DDT	Endrin	Carbaryl	Toxaphene	Methyl parathion	Monuron	Diuron	Merphos	Trifluralin	DDT	TDE	Dieldrin	Endrin
1965		Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Cotton.......	11	0.78	0.86		2.57	0.99	0.80	0.48			5.86	0.33	0.06	1.27
Oats.........	3										1.89		.05	
Wheat........	3										3.36		.08	
Soybeans.....	10										3.52	.29	.06	.33
Sorghum......	9										.46			.21
1966														
Soybeans.....	1			1.50							.64		.01	.09
Soybeans..... (combine)[1]	1			--							--	--	--	--
Soybeans.....	2									0.72	5.54		.11	1.59
Soybeans.....	3										2.91		.08	.17
Soybeans..... (combine)	3										--	--	--	--
Wheat........	3										1.47		.02	.04
Sorghum......	4										1.88		.02	.31
Soybeans.....	4										3.79			.50
Soybeans.....	5			1.50							.67		.01	.06
Soybeans..... (combine)	5			--							--	--	--	--
Soybeans.....	8									.32	5.36		.14	1.06
Soybeans..... (combine)	8									--	--	--	--	--
Soybeans.....	9			1.50							.70		.01	.03
Soybeans..... (combine)	9			--							--	--	--	--
Soybeans.....	10										3.59		.06	.57
Soybeans..... (combine)	10										--	--	--	--
Cotton.......	11	.82	1.57		1.64	1.54			0.10	.32	6.78		.06	1.11
Soybeans.....	12			1.50							1.15			.10
Soybeans..... (combine)	12			--							--	--	--	--
Soybeans.....	15			.38							4.31		.06	.92
Soybeans..... (combine)	15			--							--	--	--	--

Year and crop	Block	Soil analyses--Continued			Crop plant analyses						Crop analyses			
		Toxaphene	Trifluralin	Aldrin	DDT	TDE	Dieldrin	Endrin	Methyl parathion	Merphos	DDT	Dieldrin	Endrin	Toxaphene
1965		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Cotton.......	11		0.08		0.45	0.07	0.02	0.45						
Oats.........	3			0.06	.27	.01	.02	.05			.02			
Wheat........	3			.03							.03			
Soybeans.....	10				.28			.05			.01			
Sorghum......	9				.04			.07			.10		0.13	
1966														
Soybeans.....	1				.19			.01					.31	
Soybeans..... (combine)[1]	1	--	--	--	--	--	--	--	--	--	.02		.17	
Soybeans.....	2	8.21	.07		.18			.03					.16	
Soybeans.....	3	1.37			.19								.21	0.23
Soybeans..... (combine)	3	--	--	--	--	--	--	--	--	--			.38	
Wheat........	3	2.76												
Sorghum......	4				.14						1.13		.02	
Soybeans.....	4	3.65	.08		.17			.09					.21	
Soybeans.....	5		.05		.24			.07					.32	
Soybeans..... (combine)	5	--	--	--	--	--	--	--	--	--	.01		.35	
Soybeans.....	8	4.11	.17		.32		.01	.20					.54	
Soybeans..... (combine)	8	--	--	--	--	--	--	--	--	--	.01		.33	
Soybeans.....	9				.64			.03			.01		.18	.50
Soybeans..... (combine)	9	--	--	--	--	--	--	--	--	--	.02		.11	
Soybeans.....	10	4.48	.11		.33			.08					.34	.22
Soybeans..... (combine)	10	--	--	--	--	--	--	--	--	--	.01		.29	
Cotton.......	11	7.66			.16			.66	0.01	0.58				
Soybeans.....	12				.25			.05					.27	.59
Soybeans..... (combine)	12	--	--	--	--	--	--	--	--	--	.01		.08	
Soybeans.....	15	5.77	.15		.18			.15					.26	
Soybeans..... (combine)	15	--	--	--	--	--	--	--	--	--	.01	0.01	.56	

[1] Samples taken from combine bins during harvest.

The wheat samples were taken from the same block in 1965 and 1966. The residue of DDT found in the accompanying soil sample was less than half as much in 1966 as in 1965. Endrin and toxaphene were found in the 1966 soil sample but not in the 1965 sample. No pesticides were detected in the straw or grain in 1966.

The sorghum grain collected in 1966 contained 1.13 p.p.m. of DDT, while the sorghum plants had only 0.14 p.p.m. DDT, dieldrin, and endrin were found in the accompanying soil.

In 1966, cotton was sampled in the same block that it was in 1965. Residues of DDT, dieldrin, and endrin in the soil did not change very much by 1966, and 7.66 p.p.m. of toxaphene was found.

DDT and endrin were found in cotton stalks. DEF (0.58 p.p.m.) was also found and was probably due to foliage treatment. No residues were found in the cottonseed sample in 1966.

Drift studies on forage at GRA were limited to one year's sampling because the pasture block was placed under cultivation late in 1965. The following results were found in samples of pasture grass taken from block 1:

Sampling date	DDT	Dieldrin	Trifluralin	Endrin
	P.p.m.	P.p.m.	P.p.m.	P.p.m.
April 13	0.06	0.03	0.01	
May 13	.02	.01		
June 8	.19	.01		
July 13	.26			0.12
Nov. 10				

It is interesting to note that block 1 was never treated with pesticides, so there is apparently some drift contamination of forage at GRA.

E. Water and Sediment Analyses

Contained surface water was collected from five locations in a slough that was entirely contained by area GRA (figure 2). These five locations were designated as 16W, 18W, 24W, 25W, and 26W. Little difference in residues was found among locations, so the data from all five are lumped together and presented in table 27.

Examination of the data reveals that pesticide residues were most commonly detected in sediment, and that the most commonly detected pesticides in water and sediment were the DDT complex. With few exceptions, pesticide levels in water were low (very few were higher than 0.1 p.p.b.).

Residues of TDE and DDE were found in every sediment sample, and DDT was found in all but six of the sediment samples. The time of year that sampling was done appears to have little, if any, effect on residue levels in sediment at GRA.

Other pesticides found in water and sediment from the slough at GRA were dieldrin, endrin, chlordane, and lindane. Of these, all but dieldrin and endrin were of minor occurrence and were found only in water.

Dieldrin was detected in slightly more than one-fourth of the water samples and in one-half of the sediment samples. The amounts detected, however, were small. Endrin, on the other hand, was found in half of the water samples but only in four sediment samples. Endrin levels were much higher than dieldrin levels in water, but the largest residue was only about 5 p.p.b.

Table 27.--Pesticide residues in contained surface water and in sediment in 1965, 1966, and 1967: Area GRA

NOTE: Empty spaces indicate no residues detected.

Sampling date	Rainfall[1]	DDT		TDE		DDE		Dieldrin		Endrin		Chlordane		Lindane	
		Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment
1965	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Apr. 20..........	1.30		0.36		0.31		0.35	0.00002	0.07	0.00019					
May 6 & 7........			.21		.70		.29				0.07				
May 17...........	.45		.44		.38	0.00002	.25	.00013		.00073					
June 10..........			.11		.37		.16								
June 14..........	2.94		.44		.73		.32		.02						
June 28..........			.09		.57		.27								
July 12..........			.14		.57		.29								
July 26..........			.20		.89		.39		.03						
Aug. 9...........	.25	0.00002	.14	0.00005	.95		.46		.02						
Aug. 23..........		.00069	.20	.00015	1.27	.00024	.53	.00011		.00066					
Sept. 8..........				.00004	.22	.00002	.16			.00005		0.00002			
Sept. 21.........	1.46	.00002		.00010	.31	.00008	.16			.00011					
Oct. 5...........					.46		.16								
Oct. 19..........			.22		1.67		.36								
Nov. 2 & 3.......			.12		1.92		.29	.00008	.13						
1966															
Feb. 21..........		.00005	.62	.00002	1.06	.00005	.85	.00008	.11	.00083	.23				
Mar. 30..........			.23	.00005	1.02	.00002	.27	.00001	.05	.00012					
Apr. 27..........	.17		.25	.00007	1.00	.00004	.27	.00001	.02	.00037					
June 14..........	.03		.37		1.25		.57		.05					0.00025	
June 28 & 29.....			.15		1.08		.49		.03					.00005	
July 11..........			.33		1.55		.79		.05					.00080	
July 25..........			.38		.92		.40		.02						
Aug. 8...........		.00013	.27		.74	.00006	.59		.06	.00051					
Aug. 22..........		.00006	.39		1.54	.00004	.58	.00001	.04	.00311	.06				
Sept. 6..........			.51		1.95	.00022	.74	.00003	.04	.00499					
Sept. 19.........	.41		.89		2.29	.00009	.85	.00002	.03	.00355					
Oct. 4...........				.00011	1.62	.00009	.33								
Nov. 28..........	.04		.22		1.76	.00004	.96			.00070					
Dec. 30..........			.32		1.58		.92			.00235					
1967															
Jan. 26..........			.36		1.08		.68			.00084	.01				

[1] Rainfall listed was recorded on the sampling date, one day before, or both.

Table 28.--Pesticide residues in quick runoff water in 1965 and 1966: Area GRA

NOTE: Empty spaces indicate no residues detected.

Sampling date	Rainfall[1]	DDT	TDE	DDE	Dieldrin	Endrin	Lindane
1965:	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
May 22..........	0.80	0.00015	0.00010	0.00009	0.00026	0.00077	0.00004
May 27..........	1.03	.00010		.00003	.00007	.00137	.00024
Sept. 11........	3.68		.00013	.00008		.00012	
Sept. 21........	1.46	.00004	.00017	.00006		.00021	
Oct. 6..........	1.49		.00015	.00005		.00002	
1966:							
Jan. 2..........	1.92	.00026		.00009	.00010	.00068	
Feb. 1..........	.80	.00013		.00005	.00012	.00174	
Feb. 10.........	6.54	.00032		.00012	.00013	.00334	
Apr. 21.........	1.61+	.00008	.00023	.00005	.00013	.00123	
Aug. 12.........	1.54	.00011		.00005	.00005	.00510	
Oct. 4..........	2.05					.00112	
Nov. 10.........	2.10	.00045		.00004		.00178	
Dec. 9..........	3.20	.00035	.00008	.00003		.00379	

[1] Rainfall listed was recorded on the sampling date, one day before, or both.

Quick runoff water samples collected at GRA consistently contained pesticide residues, but the amounts detected were small (table 28). Members of the DDT complex and endrin were found in all of the quick runoff samples. Dieldrin was found in a little more than half of the samples, and lindane was found in two samples. The amount of rainfall resulting in the quick runoff appeared to have little bearing on the magnitude of residue in the water.

F. Aquatic and Terrestrial Organism Analyses

Aquatic organisms were collected from the wholly contained slough at GRA (figure 2). They included fish, turtles, crayfish, frogs, algae, and one sample each of plankton and salamanders (table 29).

The pesticides detected in aquatic organisms were the DDT complex, dieldrin, endrin, chlordane, and ethion. All of the samples but one contained at least one member of the DDT complex. The largest amounts were found in fish, with little, if any, difference among species.

All of the turtles sampled in 1965 contained DDE in amounts ranging from 0.13 p.p.m. to 7.18 p.p.m. Residues of the same chemical ranged from 0.07 to 0.18 p.p.m. in 1966. The amounts of dieldrin and endrin in turtles were also much less in 1966.

DDT-complex pesticides detected in crayfish did not appear to change very much between 1965 and 1966. Three of the samples collected in 1966 did, however, contain ethion, which was not detected in any other organism sampled.

All of the frogs and tadpoles sampled were found to contain chemicals of the DDT complex. The amounts found were second only to those found in fish.

Algae collected at GRA consistently contained DDT and its isomers, which could be the reason behind some of the large residues found in fish.

The pesticides found in plankton and salamanders were similar in kind and amount to those found in the other organisms analyzed.

Terrestrial organisms sampled at GRA included cotton rats, mice, rabbits, earthworms, and snakes. Samples of chicken eggs and beef fat were also collected (table 30).

As with other organisms, the most commonly detected pesticides found in terrestrial species were of the DDT family. Also found were dieldrin and endrin. For the most part, residue

Table 29.--Pesticide residues in aquatic organisms: Area GRA[1]

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Organisms	1965 sampling season						1966 sampling season							
	Date of sampling	DDT	TDE	DDE	Dieldrin	Endrin	Date of sampling	DDT	TDE	DDE	Dieldrin	Endrin	Chlordane	Ethion
		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Notropis sp. (minnows)	Nov. 1	0.22	1.23	3.05		1.97	June 27	0.56	3.73	2.83	0.13	0.16	0.53	
	--	--	--	--	--	--	Aug. 1	1.33	7.11	1.96	.19	.41	.47	
	--	--	--	--	--	--	Sept. 9	.90	4.78	2.57	.14	.75	.67	
Lepomis macrochirus (blue gill)	Mar. 31						--	--	--	--	--	--	--	--
Gambusia sp. (Gambusia)	--	--	--	--	--	--	May 4	2.90	2.10	1.34	.17	.46	.43	
	--	--	--	--	--	--	June 3	1.68	3.77	1.61	.16	.33	.44	
	--	--	--	--	--	--	Aug. 1	4.06	11.83	4.31	.51	.77	1.88	
	--	--	--	--	--	--	Sept. 9	1.32	3.95	1.82	.13	.87	.60	
Pseudemys scripta elegans (red-eared turtle)	June 3			.13			June 15	.13		.11	.03			
	June 27	.08		.73			July 7	.04		.18	.02			
	July 19			.17			Aug. 16	.04		.10	.02			
	Aug. 31	.12		1.57	0.06		Sept. 16	.04		.07	.01	.05		
	Oct. 4	.10	.08	1.65	.10	.82	--	--	--	--	--	--	--	--
	Nov. 8			7.18	.49		--	--	--	--	--	--	--	--
Crayfish	May 24	1.79	.81	3.11			April 1 to April 18	1.30	.85	.98				1.04
	June 23	1.05	.54	1.09			May 16	.78	.46	1.09				.64
	Aug. 23	.10	.20	1.61			June 16 to June 24.	.16	.43	2.00				
	Nov. 24		.12	.62			Aug. 5	.36	.66	1.43				.57
Frogs (unidentified)	April 19	1.96	.32	2.80	.40	.48	--	--	--	--	--	--	--	--
	June 25			.80			--	--	--	--	--	--	--	--
Acris sp. (cricket frogs)	May 5	.51	.29	2.34	.15		--	--	--	--	--	--	--	--
	June 25	3.29	.51	4.30	.31		--	--	--	--	--	--	--	--
	May 18	.10	.10	1.35	.12		--	--	--	--	--	--	--	--
	Aug. 3	.13		1.06			Aug. 5	.95	.71	2.87	.08			
	Sept. 15	.88	.12	.94	.06		--	--	--	--	--	--	--	--
	Oct. 21	3.80	.71	1.60	.14		--	--	--	--	--	--	--	--
Tadpoles (Acris sp. & Rana sp. in 1966)	May 24	1.91	1.53	1.73			Aug. 4	.76	2.78	1.86	.11			
	June 15	.49	.40	.66			--	--	--	--	--	--	--	--
	June 23	2.30	1.28	1.75			--	--	--	--	--	--	--	--
Algae	May 13	4.06	1.91	2.10	.20	.43	May 31	.29	.03	.09	.01	.05		
	April 30	2.34	.99	1.43	.18	1.31	June 15		.04	.06				
	June 10	.14	.50	.37	.11	.27	Sept. 22	.16	.80	.10	.23			
	June 28	.43	.38	.38	.01	.82	--	--	--	--	--	--	--	--
	Aug. 3					.01	--	--	--	--	--	--	--	--
Plankton	Oct. 22	1.50	.59	.30	.82	.82	--	--	--	--	--	--	--	--
Amphiuma sp. (salamander)	--	--	--	--	--	--	June 27	.12	1.44	2.42	.84			

[1] All samples taken from one pond.

Table 30.--Pesticide residues in terrestrial organisms: Area GRA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Organisms	1965 sampling season						1966 sampling season						
	Date of sampling	DDT	TDE	DDE	Dieldrin	Endrin	Date of sampling	DDT	TDE	DDE	Dieldrin	Endrin	Hepta-chlor-epoxide
		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Sigmodon hispidus...... (hispid cotton rat)	Apr. 1............	0.03		0.05			May & June.........	0.05	0.01	0.13			
	Nov................	.02	0.01	.10			Nov................	.11	.05	.12	0.01		
Peromyscus sp.......... (mice)	Apr................	.02	.02	.08	0.14	0.07	--	--	--	--	--	--	--
Mus m. musculus........ (house mouse)	Nov................	.07	.01	.16	.07	.12	May & June.........	.25	.04	1.27	.22	0.05	0.03
	--	--	--	--	--	--	Nov................	.45	.07	.17	.04	.22	
Sylvilagus floridanus.. (rabbits)	Apr. 26 to Apr. 29.						May................						
	Nov................	.01		.01			Nov................	.02					
Earthworms............	Apr. & May.........	.16				.04	--	--	--	--	--	--	--
	Sept...............	.42	.05	.10		.33	--	--	--	--	--	--	--
	Oct. 11............	.11	.04	.08		.30	--	--	--	--	--	--	--
Natrix sp............. (water snakes)	May................	.43	.53	8.51	.45		May 2.............	1.76	.50	13.61	.35		
Chicken eggs..........	Jan. 7............	.91	.01	1.14	.09	.66	--	--	--	--	--	--	--
Beef fat..............	Feb. 8............	.25	.11	.88	.14	.11	--	--	--	--	--	--	--

Table 31.--Pesticide residues in birds (nestlings) and bird eggs: Area GRA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Species	1965 sampling season					1966 sampling season					
	Date of sampling	DDT	TDE	DDE	Dieldrin	Date of sampling	DDT	TDE	DDE	Dieldrin	Endrin
		P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Passer d. domesticus (English sparrow)	Aug. 3.			0.33		May 2...			1.65	0.08	
Eggs..........	--	--	--	--	--	May 11..	6.00	1.41	5.24	.09	
Sturnus vulgaris.... (starlings)	--	--	--	--	--	May 2...			12.14	1.31	1.13
Blackbirds.......... (unident.)	--	--	--	--	--	June 17.			1.66	.04	
Eggs..........	--	--	--	--	--	May 6...	.73	.42	29.70	1.14	.36

levels were low in the species sampled. A notable exception to this was 8.51 p.p.m. and 13.61 p.p.m. of DDE found in water snakes in 1965 and 1966, respectively.

It is interesting to note that only three residues were found in four rabbit samples, and that these residues were all 0.01 p.p.m. There is apparently very little accummulation of pesticides by rabbits at GRA, in spite of the fact that they probably feed on pesticide--contaminated foliage.

The single sample each of chicken eggs and beef fat, were found to contain the DDT, complex, dieldrin, and endrin. Residues were largest in chicken eggs, except that dieldrin was slightly higher in beef fat.

Only three species of birds were sampled at GRA, and only a few samples of those were obtained. DDE, dieldrin, and endrin were found in the nestling birds; the entire DDT complex, dieldrin, and endrin were found in bird eggs (table 31). As found at CHA, residues were quite large in bird eggs (59.39 p.p.m. of DDE was found in one sample). Relatively high levels of DDE, dieldrin, and endrin, however, were detected in starling nestlings.

III. AREA STB

A. General Description

Area STB was established near Stuttgart, Ark., to monitor the environmental effects of aldrin as used in treating rice seed. At STB, rice is rotated with soybeans.

There are 469 acres under cultivation at STB. In 1964, rice was grown on 110 acres, soybeans on 198 acres, and oats on 161 acres. In addition to the cultivated land, there are 39 acres of woodland and a reservoir covering 166 acres (figure 3).

Investigation of pest-control practices on farms adjacent to STB indicate that pesticide use on the study area is similar to that of the surrounding community. An exception to this was the use of methyl parathion on two nearby farms.

Weather data for STB are listed in table 32.

B. Soil Description

On the nearly level to gently sloping uplands, the dominant surface soils are gray-brown silt-loam to a depth of 6 to 8 inches. The subsurface layer is a lighter gray soil of similar texture, which extends to 18 inches. The subsoil is gray, clayey, and mottled with red (this layer

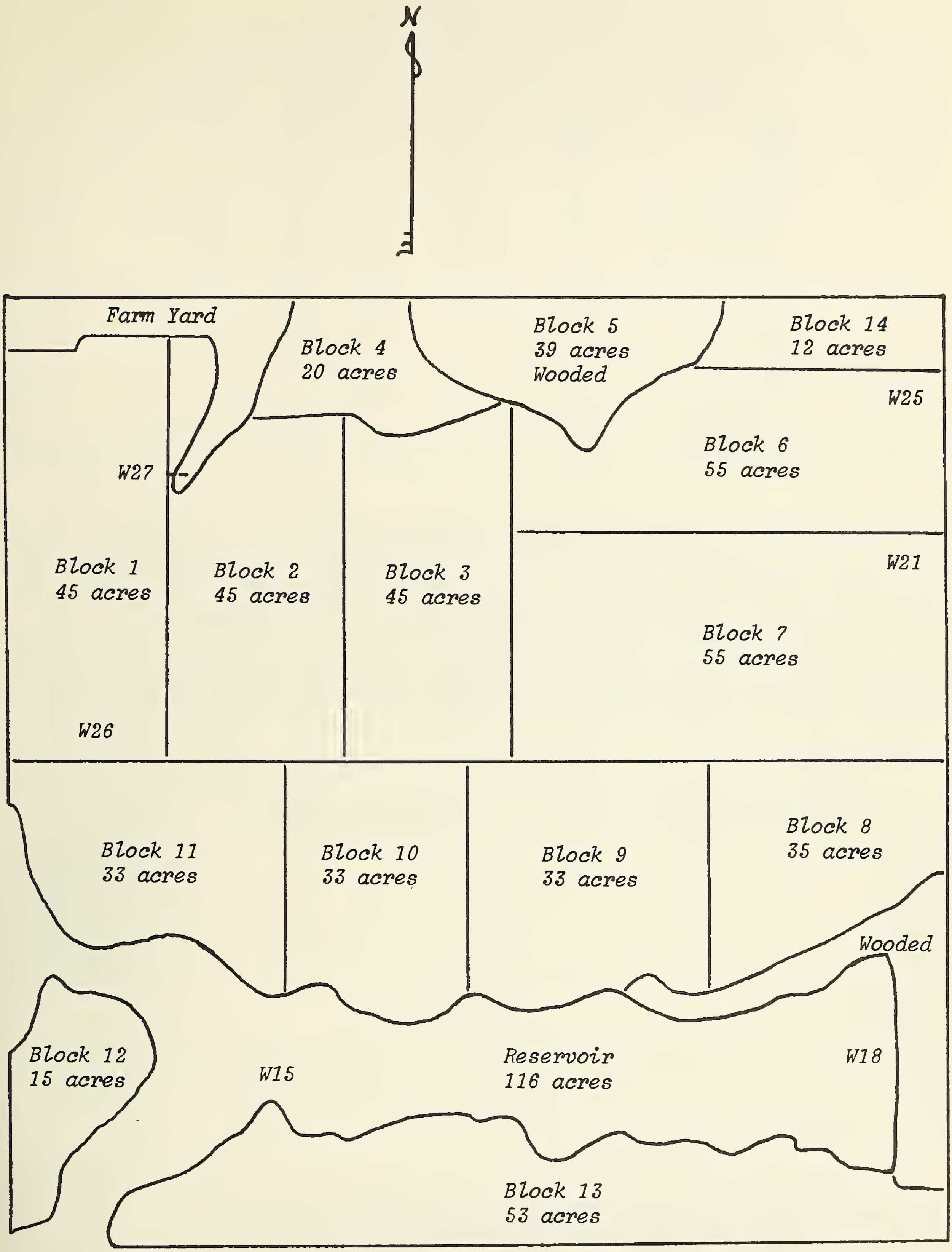

Figure 3.--Outline map: Area STB

Table 32.--Weather data: Area STB

NOTE: Dashes indicate no sample was analyzed or no information was available.

Year and month	Temperature		Relative humidity		Total rainfall
	Minimum	Maximum	Minimum	Maximum	
1965:	°F.	°F.	Pct.	Pct.	In.
March	19	75	30	100	5.99+
April	38	87	23	100	1.45
May	48	89	29	100	2.18+
June	54	93	40	100	2.24+
July	56	99	40	100	0
Aug	56	97	33	100	1.48
Sept	43	93	39	100	7.86
Oct	30	86	20	100	.52
Nov	25	84	--	100	1.30+
Dec	18	74	--	100	1.54+
1966:					
Jan	1	68	38	100	2.53
Feb	20	84	--	100	7.60
March	23	85	--	100	.50+
April	31	82	22	100	7.49+
May	43	90	34	100	1.95+

is commonly called claypan). The subsoil grades into a mottled-gray and brown, silty-clay substratum at about 3-1/2 feet. This layer commonly extends from several to many feet deep. The surface and subsurface layers are strongly acid but become less acid in the substratum. These soils are low in plant nutrients. The claypan layer is an undesirable feature.

The less extensive soils on near-level terraces along streams have brown silt-loam surface layers with somewhat finer textured yellow-brown subsoils, which are very firm and mottled in the lower part (fragipan). At about 3-1/2 feet the substratum is loamy. These soils are low to medium in plant nutrients and are acid throughout.

C. Soil Analyses

The pesticides found in soils at STB were limited to DDT, TDE, aldrin, and dieldrin. The use records for STB indicate the following pesticides were applied:

Before 1965	1965	1966
aldrin*	aldrin*	aldrin*
captan	captan	captan
2,4-D*	2,4-D*	Panogen
DDT*	ethyl parathion*	propanil*
ethyl parathion*	methyl parathion*	
Panogen	Panogen	
propanil*	propanil*	
2,4,5-T*	2,4,5-T*	
toxaphene*	TDE*	
	toxaphene*	

*Analyzed for.

Generally low levels of DDT (and its DDE isomers) were found in soil at STB (table 33). Residues were found in eight of the nine fields treated with DDT before 1965, and in three fields with no record of DDT use; however, the largest residue found was only 0.2 p.p.m.

TDE residues in soil have been recorded separately from the DDT complex at STB because that chemical was used on half of the blocks in 1965 (STB was the only area with a record of TDE use).

Table 33.--Combined DDT residues in soil: Area STB

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965 Spring	1965 Amount applied	1965 Fall	1966 Spring	1966 Amount applied	1966 Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.........	45	0.69	0.09	0	0.08	0.17	0	0.01
2.........	45	.47		0	.08	.07	0	
3.........	45	.88	.03	0	.14	.17	0	.09
4.........	20	1.38		0			0	
5.........	39	0	.12	0	.06	.10	0	.11
6.........	55	1.38		0	.01	.10	0	
7.........	55	1.38	.08	0			0	
8.........	35	0		0			0	
9.........	33	0		0			0	
10.........	33	0		0	.20	.05	0	
11.........	33	0		0	.08		0	.01
12.........	15	.69	.05	0	.08		0	
13.........	53	.69	.03	0	.08	.08	0	
14.........	12	1.38	.12	0	.10	.12	0	.13
Acreage-weighted averages:		0.646	0.035	0	0.062	0.068	0	0.021

Table 34.--TDE residues in soil: Area STB

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965 Spring	1965 Amount applied	1965 Fall	1966 Spring	1966 Amount applied	1966 Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1........	45	0		1.00	0.15	0.12	0	0.06
2........	45	0		.16			0	
3........	45	0		.55	.16	.12	0	.08
4........	20	0		0			0	
5........	39	0		0			0	
6........	55	0		0			0	
7........	55	0		0			0	.02
8........	35	0		0			0	
9........	33	0		0			0	
10........	33	0		1.00	.15	.13	0	.06
11........	33	0		1.00	.09	.13	0	.08
12........	15	0		1.00	.11	.14	0	.07
13........	53	0		1.00	.13	.12	0	.08
14........	12	0		0		.03	0	.01
Acreage-weighted averages:		0		0.407	0.059	0.054	0	0.034

Residues of TDE found in STB soils are recorded in table 34. Low levels were detected in all but one treated block, and very small TDE residues were detected in two blocks with no record of treatment. However, both fields had been treated with DDT. As mentioned before, aldrin is used to treat rice seed at STB. Examination of table 35 shows an average of 0.596 lb/A was used at STB prior to 1965, and that two blocks in 1965 and six blocks in 1966 received aldrin treatments. As shown by the data, only small amounts of aldrin were recovered from a few scattered soil samples.

At this point it may be convenient for the reader to refer to table 36, which contains the dieldrin residues detected in STB soils. There was no known use of dieldrin at STB, but that chemical was found in most blocks at every sampling. These residues obviously resulted from aldrin degradation. The largest dieldrin residue found did not exceed 0.25 p.p.m.

Table 35.--Aldrin residues in soil: Area STB

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.........	45	0.33		0			0.37	0.01
2.........	45	1.17	0.10	0			.06	
3.........	45	1.04		0			0	
4.........	20	.48		0			0	
5.........	39	0		0			0	
6.........	55	.48		0.19	0.03		.06	.01
7.........	55	.48		.19			.06	
8.........	35	1.21	.03	0			0	
9.........	33	1.21	.07	0			0	
10.........	33	.33		0			0	
11.........	33	.33		0			0	.01
12.........	15	.33		0			.37	.03
13.........	53	.33		0			.37	.01
14.........	12	.48		0			0	
Acreage-weighted averages:		0.596	0.015	0.040	0.003		0.099	0.004

Table 36.--Dieldrin residues in soil: Area STB

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1........	45	0		0			0	0.08
2........	45	0	0.05	0	0.14	0.23	0	.18
3........	45	0		0	.04	.05	0	.03
4........	20	0		0			0	
5........	39	0		0			0	
6........	55	0		0	.05	.15	0	.11
7........	55	0	.06	0	.08	.14	0	.09
8........	35	0	.06	0	.08	.10	0	.06
9........	33	0	.05	0	.08	.10	0	.06
10........	33	0	.08	0	.09	.12	0	.09
11........	33	0	.08	0	.08	.15	0	.06
12........	15	0	.14	0	.08	.13	0	.09
13........	53	0	.10	0	.08	.10	0	.10
14........	12	0		0			0	.02
Acreage-weighted averages:		0	0.042	0	0.061	0.099	0	0.077

D. Paired Crop and Soil Analyses

Crop samples were collected only in 1965 at STB because of the limited number of crops grown and the reduction of sampling activity in May 1966.

The crops sampled at STB were oats, rice, and soybeans (table 37). The small residues detected in soil were DDT, TDE, dieldrin, aldrin, and 2,4-D. Somewhat larger residues of DDT and TDE were found in soybean plants, but no residues were found in the soybeans.

Rice straw contained aldrin, 2,4-D, DDT, and TDE, but no residues were found in the accompanying soil sample. A very small aldrin residue was detected in the rice itself.

Table 37.--Pesticide residues in paired crop and soil samples in 1965: Area STB

NOTE: Empty spaces indicate no residues detected. No samples were taken in 1966.

Crop	Block	Amount applied						Soil analyses					Crop plant analyses			
		TDE	Toxaphene	Methyl parathion	Aldrin	2,4-D	Ethyl parathion	DDT	TDE	Dieldrin	Aldrin	2,4-D	DDT	TDE	Dieldrin	Aldrin
		Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Oats....	11		2.00							0.09						
Rice....	6				0.19	1.00	0.40			.08	0.11	0.06	0.62	0.05	0.04	0.002
Soybeans	9												.30	.17		
Soybeans	11	1.00		0.25				0.02	0.07	.08			.27	2.75		

Table 38.--Pesticide residues in contained surface[1] water and sediment in 1965 and 1966: Area STB

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Sampling date	Rainfall	Dieldrin		Aldrin	
		Water	Sediment	Water	Sediment
1965	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Mar. 26............	2.42				
Apr. 23............					
May 20[2]............	.02		0.03		0.17
May 26............	.52				
May 27............	---				
June 14............	.87				
June 21[2]............					
June 24............	.28				
Aug. 18............					
Sept. 14............					
Oct. 13............					
Nov. 9............	1.13				
Dec. 8............		0.00008			
1966					
Feb. 18............		.00006			
Mar. 29............					
Apr. 27............	.33				
Sept. 8............	---				
Oct. 4 & 5..........	---				
Dec. 28............	---				

[1] Farm reservoir.
[2] Sump under railroad tracks.

Toxaphene was found in oat straw and oats; however, since the analyses were done by colorimetry, they were subject to sulfur interference.

E. Water and Sediment Analyses

All but two of the contained surface water samples were taken from the large reservoir at STB (figure 3). The remaining two samples were taken from a sump along the east side of the area. Examination of table 38 shows that only two water samples (both from the reservoir), and only one sediment sample (from the sump) contained detectable residues. Very small amounts of dieldrin were found in the water samples, while relatively small amounts of dieldrin and aldrin were found in the sediment sample.

During the course of monitoring STB, seven samples of quick-runoff water were collected (table 39). Only three of these samples were accompanied by sediment samples. No residues were detected in sediment, and only two water samples contained very small residues (TDE in one, dieldrin in both).

Table 39.--Pesticide residues in quick runoff water and sediment in 1965 and 1966: Area STB

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Sampling date	Rainfall[1]	TDE		Dieldrin	
		Water	Sediment	Water	Sediment
1965	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Feb. 10.............	--		--		--
Aug. 25.............	0.17				
Sept. 11............	5.00	0.00008	--	0.00004	--
Sept. 22............	.82		--		--
1966					
Feb. 10.............	4.70		--		--
Apr. 18.............	.25				
Apr. 24.............	2.90			.00009	

[1] Rainfall listed was recorded on the sampling date, one day before, or both.

Table 40.--Pesticide residues in irrigation water and sediment in 1965: Area STB

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Sampling Date	Rainfall[1]	DDE		Dieldrin		Aldrin		Endrin	
		Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment
	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
May 6[2].........		0.00004	--	0.00002	--		--	0.00017	--
May 18[3]........	0.13							.00074	
June 9[4]........									
June 20[3].......									
June 25[3].......	.28								
Sept. 3.........				.00003			0.13		

[1] Rainfall listed was recorded on the sampling date, one day before, or both.
[2] Water standing in rice fields.
[3] Water exiting from fields.
[4] Water standing in a ditch before irrigation.

As noted in Table 40, irrigation water was collected from three sources: Standing water, exiting water, and entry water (from ditches). Only three water samples contained detectable residues. Small amounts of DDE, dieldrin, and endrin were found in one, endrin was found in another, and dieldrin was found in the third. One sediment sample was found to contain an aldrin residue.

F. Aquatic and Terrestrial Organism Analyses

The aquatic organisms sampled at STB, all taken from the reservoir, included fish, turtles, crayfish, toads, frogs, algae, and mussels (table 41). Most of these samples were collected in 1965.

The residues in aquatic organisms at STB reflect those found at CHA and GRA. The DDT complex and dieldrin were the most commonly detected pesticides. The largest residues were found in fish and toads.

Nearly all of the turtle samples contained residues, but at relatively low levels. Very few residues were found in crayfish or tadpoles (the largest residue found in either group was less than 1 p.p.m.). All of the mussel samples contained small amounts of the DDT-complex

Table 41.--Pesticide residues in aquatic organisms: Area STB

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Organisms	1965 sampling season							1966 sampling season				
	Date of sampling	DDT	TDE	DDE	Dieldrin	Endrin	Chlordane	Date of sampling	DDT	TDE	DDE	Dieldrin
		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.
Minnows	May 11	0.06	0.50	0.15	0.16			--	--	--	--	--
(unident.)	June 23	.12	.06	.12	.08			--	--	--	--	--
	Aug. 2	.06	.06	.05	.02			--	--	--	--	--
Fish (unident.)	--	--	--	--	--	--	--	May 19	0.10	0.46	0.49	0.03
Ameiurus sp.	May 28	.28	.20	.22	.17			--	--	--	--	--
(catfish)	July 9	.08	.11	.20	.05			--	--	--	--	--
Ictalurus sp.	July 9	.24	.19	.20	.16			Mar. 21	.08	.62	.16	.04
(bullheads)	Aug. 21	.12	.18	.24	.05			Apr. 15	.05	.51	.12	.09
	Sept 17	.28	.61	.58	.06			May 18	.23	2.03	.36	.26
	Oct. 21	.21	1.10	.59	.12			May 19	.26	.74	.20	.05
	Nov. 23	.06	.44	.17	.02			--	--	--	--	--
Pomoxis annularius (crappie)	--	--	--	--	--	--	--	Apr. 19		.21	.08	.02
Lepisosteus sp. (gar)	--	--	--	--	--	--	--	Mar. 15	.26	.63	.73	.04
Pseudemys scripta elegans	Apr. 27							Mar. 10 to Mar. 18	.01		.03	.05
(red-eared turtle)	Aug. 13			.13	.01			Apr. 13 to Apr. 24	.01	.01	.06	.21
	Oct. 14 to Oct. 19		.01	.06	.03			May 19	.05	.02	.29	.44
	Nov. 14	.02	.02	.11	.04			--	--	--	--	--
Chrysemys picta dorsalis	June 15			.01				--	--	--	--	--
(southern painted turtle)	July 9				.01			--	--	--	--	--
Turtle (unident.)	Sept. 13 to Sept. 17			.02	.01			--	--	--	--	--
Crayfish	Apr. 13-26		.02	.07				--	--	--	--	--
	May 11	.11	.02	.06	.02			Apr. 13 to Apr. 26.		.02	.70	
	May 28							--	--	--	--	--
	June 23							--	--	--	--	--
	Aug. 3							--	--	--	--	--
	Sept. 2		.17	.54				--	--	--	--	--
Bufo woodhousei	Apr. 30	.08	.42	1.40	.13			--	--	--	--	--
(toads)	June 15	.31		1.58	.85			--	--	--	--	--
	June 28	.47	.06	1.70	.65			--	--	--	--	--
	July 28	.09		.61	.23			--	--	--	--	--
	Aug. 24			.15	.08			--	--	--	--	--
	Sept. 28		.52	.18	.07			--	--	--	--	--
	Nov. 5	.30	.50	.53	.52			--	--	--	--	--
Rana catisbeiana (bullfrogs)	--	--	--	--	--	--	--	Apr. 20 to May 19.				
Tadpoles	May 11							--	--	--	--	--
(unident.)	May 28	.01		.01				--	--	--	--	--
	June 23							--	--	--	--	--
	Sept. 3	.14	.14	.10				--	--	--	--	--
Algae	June 15		.01	.22		0.01		--	--	--	--	--
	July 6		.21	.34	.01	.10		--	--	--	--	--
	Aug. 5		.15	.01	.24			--	--	--	--	--
	Sept. 13							--	--	--	--	--
	Sept. 27		21.62	.39			0.07	--	--	--	--	--
Mussels	May 28	.04	.02	.03	.03			--	--	--	--	--
	June 21	.06	.03	.04	.03			--	--	--	--	--
	Aug. 2	.03	.01	.02	.01			--	--	--	--	--
	Sept. 3	.05	.14	.05	.02			--	--	--	--	--

Table 42.--Pesticide residues in terrestrial organisms: Area STB

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Organisms	1965 sampling season					1966 sampling season					
	Date of sampling	DDT	TDE	DDE	Dieldrin	Date of sampling	DDT	TDE	DDE	Dieldrin	Aldrin
		P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Peromyscus leucopus... (white-footed mouse)	Apr. 22 to May 7.	0.05		0.08	0.04	Mar. 29 to Apr. 19	0.08		0.25	0.20	
Mus musculus.......... (house mouse)	Nov. 1 to Dec. 30	.01	0.01	.03	.01	Mar. 30 to May 13.	.10		.06	.11	
Sigmodon hispidis..... (hispid cotton rat)	Nov. 3 to Dec. 6.					Mar. 29 to May 13.	.06	0.01	.05	.03	
Pitymys pinitorum..... (pine vole)	Apr. 22 to May 7.	.04	.01	.06	.03	--	--	--	--	--	--
	Nov. 1 to Dec. 30	.01		.03		--	--	--	--	--	--
Sylvilagus sp......... (rabbits)	Apr. 23 to May 11					Mar. 28 to May 12.				.01	
	Apr. 26 to Apr. 30					--	--	--	--	--	--
	Nov. 1 to Dec. 20.					--	--	--	--	--	--
	Nov. 1 to Dec. 20.					--	--	--	--	--	--
Ondatra sp............ (muskrats)	--	--	--	--	--	Apr. 2 to Apr. 22.					
Oryzomys palustris.... (rice rat)	Nov. 1 to Dec. 30.					--	--	--	--	--	--
Earthworms............	May 3 to June 28..	1.37	.12	.14		May 9 to Oct......	.24	.86	.16	.65	0.32
	July 3 to Oct. 5..		13.57	.37		--	--	--	--	--	--

chemicals and dieldrin. Algae, on the other hand, contained moderate to small amounts of dieldrin, endrin, chlordane, and the DDT-complex chemicals (one sample had 21.62 p.p.m. of TDE).

The terrestrial organisms sampled at STB included rats, mice, voles, rabbits, muskrats, and earthworms (table 42). Here again, most of the samples were collected in 1965. Residues of DDT, TDE, and DDE were the most commonly detected in all of the terrestrial organisms, but dieldrin was found primarily in mice, rats, voles, and earthworms. Except in a few samples, most of the residues found in terrestrial species were well below a half part per million. A notable exception to this was 13.57 p.p.m. of TDE found in one earthworm sample.

IV. AREAS NMA AND NMB

A. General Description

1. Area NMA. Area NMA is near Grand Forks, N. Dak., in the Red River Valley. Historically the principal crops have been potatoes, small grains, and sugar beets, with fallow included in the crop rotation. Some of the area is pasture land. This area and its pair member, NMB, were originally selected because sugar beets were a major crop. During the period of study, however, sugar beets were not grown on NMA, so sugar beets and other crops were sampled at NMB. Analyses data for NMB paired crop and soil samples are included in this report, as are aquatic and terrestrial organism data.

From 1955 to 1967, small-grain fields at NMA were treated with 2,4-D and MCPA for weed control; heptachlor and aldrin were used on sugar beets. The following list includes all of the known pesticides used on NMA:

Before 1965	1965	1966	1967
aldrin*	Ceresan	DDT*	2,4-D*
2,4-D*	2,4-D*	DNBP	maleic hydrazide
DDT*	DDT*	endosulfan*	phorate*
endrin*	DNBP	maleic hydrazide	zineb
heptachlor*	endrin*	maneb	
MCPA		MCPA	
toxaphene*		phorate*	

*Analyzed for.

Survey of pesticide use on fields surrounding NMA revealed that pest-control practices in that area are representative of those in the community. Weather data collected at NMA are presented in table 43. An outline map of the study area can be found in figure 4.

2. Area NMB. Area NMB was also located in the Red River Valley near Grand Forks, N. Dak. Sugar beets, wheat, barley, and potatoes, with fallow rotation, are the principal crops grown at NMB. A creek branch originating in the study area contained backwater most of the year. This water source allowed collection of some aquatic organisms at NMB (figure 5).

The long history of pesticide use at NMB includes applications of endrin, Guthion, and copper sulfate for control of potato and sugar beet pests.

B. Soil Description

1. Area NMA. The soils at NMA are nearly level Glyndon silt loams (moderately saline) and nearly level Borup silt loams. The Glyndon silt loam has 8 inches of black calcareous top soil underlain by 6 inches of a strongly calcareous gray layer. Below that is a 20-inch gray-brown layer. The Borup silt loam is quite different in that it has a black calcareous layer 20 inches thick on top. Underlying the top layer is 10 inches of gray silt, with an 18-inch olive-gray layer below that.

2. Area NMB. Area NMB soils are of the Fargo type. Surface soils at NMB are 6 to 7 percent organic matter and 40 to 45 percent clay. The subsoils are 55 to 60 percent clay. All of the area soils are very slowly permeable to water.

C. Soil Analyses

In general, those pesticides applied at NMA and analyzed for in soil were recovered. The principal chemicals detected were DDT, dieldrin, and endrin. Other pesticides found in NMA soils were aldrin, heptachlor epoxide, chlordane, toxaphene, 2,4-D, and endosulfan.

Residues of DDT were found in soil from all ten blocks of NMA each time they were sampled (table 44). The treatment record, however, indicates that three blocks were treated with DDT before 1965, five blocks were treated in 1965, four were treated in 1966, and none were treated in 1967. The largest residues were found in soil from blocks with a record of DDT application. Most of the residues were less than 1 p.p.m. and all were less than 1.5 p.p.m. DDT seems to be persisting in NMA soil, but it does not appear to have built up any since it was first used there.

Table 43.--Weather data: Area NMA

NOTE: Dashes indicate no sample was analyzed or no information was available.

Year and month	Temperature		Relative humidity		Total rainfall
	Minimum	Maximum	Minimum	Maximum	
1965:	°F.	°F.	Pct.	Pct.	In.
May	27	87	15	97	3.08+
June	43	88	18	96	5.19+
July	44	88	24	96	3.69
Aug	33	102	19	96	1.83+
Sept	23	70	23	96	5.25+
Oct	26	74	23	96	1.09+
1966:					
May	26	88	16	96	1.80+
June	37	94	22	96	2.55+
July	50	91	30	96	5.72+
Aug	45	92	20	97	2.39+
Sept	--	--	--	--	--
Oct	18	81	30	96	.98+
1967:					
June	33	91	34	96	2.01+
July	38	94	28	96	.76
Aug	--	--	--	--	--
Sept	--	--	--	--	--
Oct	--	--	--	--	--
Nov	-5	57	43	100	0

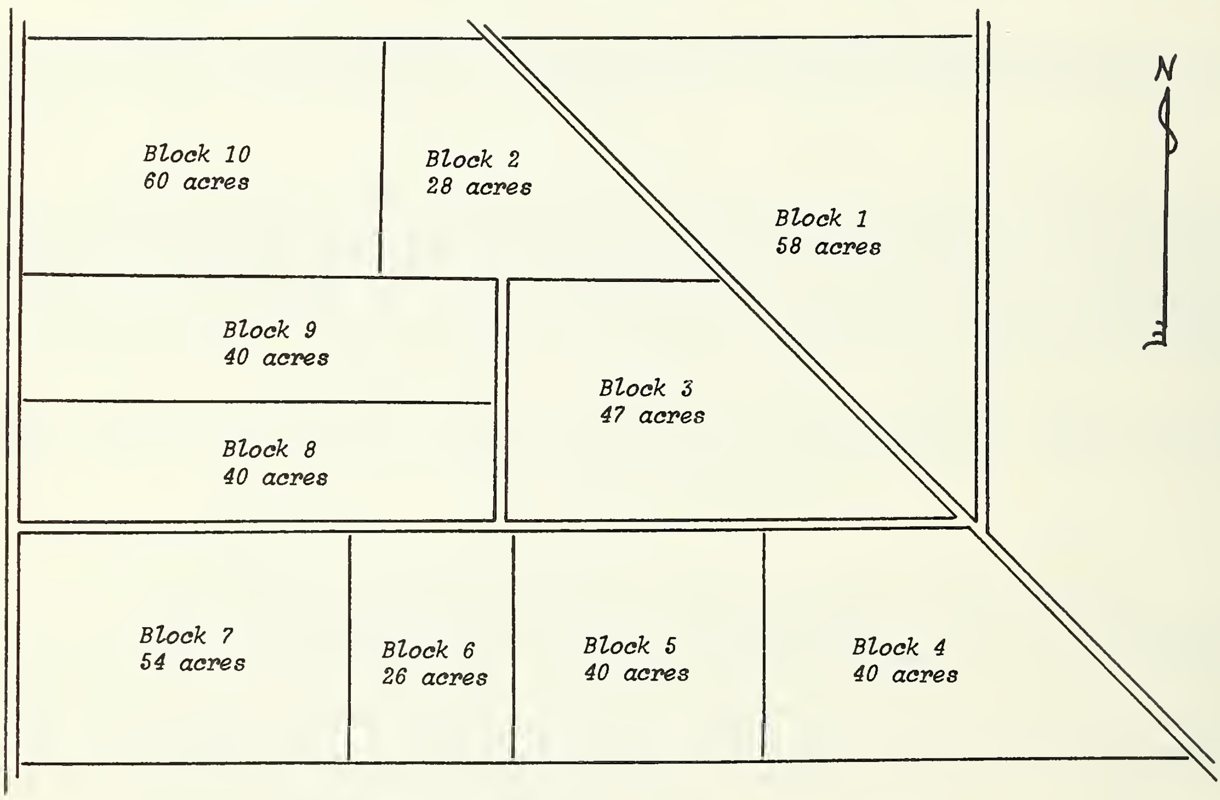

Figure 4.--Outline map: Area NMA

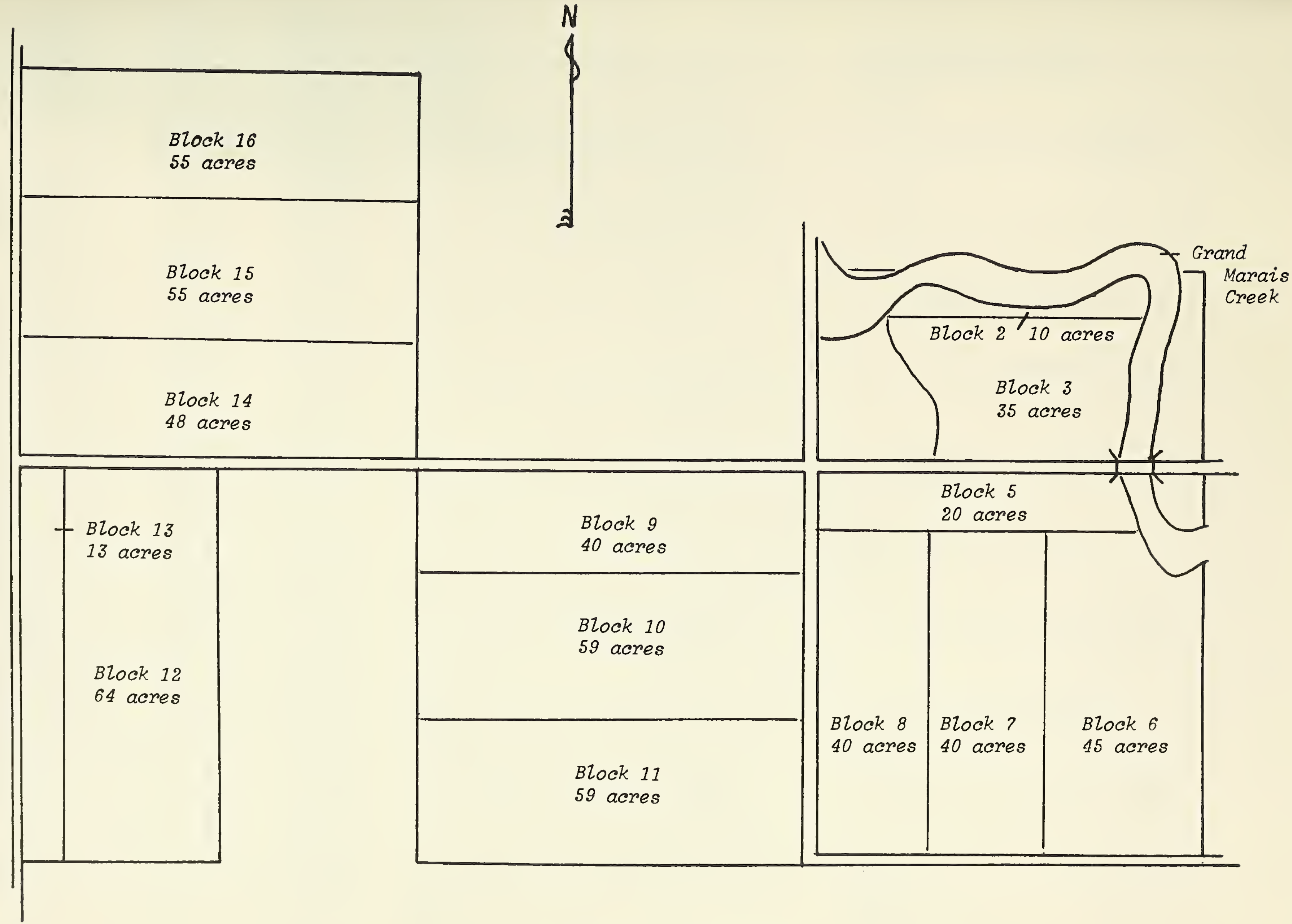

Figure 5.--Outline map: Area NMB

Table 44.--Combined DDT residues in soil: Area NMA

Block	Acres	Amount applied before 1965	1965 Spring	1965 Amount applied	1965 Fall	1966 Spring	1966 Amount applied	1966 Fall	1967 Spring	1967 Amount applied	1967 Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.......	58	0	0.18	0	0.05	0.27	0	0.31	0.25	0	0.19
2.......	28	0	.08	0	.12	.32	0.63	.46	.33	0	.24
3.......	47	0	.14	0	.19	.18	.63	.30	.38	0	.31
4.......	40	0	.05	0.50	.30	.46	0	.36	.29	0	.29
5.......	40	0	.20	.50	.29	.57	0	.78	.60	0	.48
6.......	26	0	.07	0	.14	.41	.63	.40	.47	0	.39
7.......	54	0	.08	0	.09	.17	.63	.40	.47	0	.36
8.......	40	0.38	.40	1.00	1.05	1.34	0	.98	.94	0	.86
9.......	40	.38	.40	1.00	.90	1.00	0	.87	.87	0	.84
10.......	60	.50	.12	.50	.43	.65	0	.64	.50	0	.46
Acreage-weighted averages:		0.140	0.172	0.346	0.349	0.524	0.226	0.543	0.502	0	0.435

Table 45.--Aldrin residues in soil: Area NMA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965 Spring	1965 Amount applied	1965 Fall	1966 Spring	1966 Amount applied	1966 Fall	1967 Spring	1967 Amount applied	1967 Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.......	58	3.00	0.36	0		0.02	0		0.01	0	0.01
2.......	28	3.00		0			0			0	
3.......	47	0		0			0			0	
4.......	40	0		0			0			0	
5.......	40	0		0			0			0	
6.......	26	0		0			0			0	
7.......	54	3.00		0		.01	0			0	
8.......	40	2.99		0			0			0	
9.......	40	2.99		0			0			0	
10.......	60	3.00		0			0			0	
Acreage-weighted averages:		1.938	0.048	0		0.004	0		0.001	0	0.001

Data in table 45 show that an average of nearly 2 pounds of aldrin per acre was applied at NMA before 1965. Recoveries of aldrin from the soil were very minor, although a very small amount of that chemical persisted in block 1 as long as the fall of 1967. Apparently most of the aldrin applied at NMA rapidly broke down into dieldrin.

Dieldrin was found in soil from all of the blocks at NMA during the study period (table 46). Residue levels were low and were apparently the result of aldrin degradation in at least six of the blocks. All of the dieldrin residues found in soil were less than 0.2 p.p.m., and most were less than 0.1 p.p.m.

Endrin was not used at NMA after 1965 and was never used extensively in that area. Examination of endrin residue data for soil (table 47) indicates that some endrin was found in blocks with no record of its use, but the largest amounts found were recorded for fields treated with endrin. It also appears that endrin is gradually dissipating in the soil at NMA.

Table 46.--Dieldrin residues in soil: Area NMA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.......	58	0	0.19	0	0.18	0.19	0	0.16	0.12	0	0.12
2.......	28	0	.09	0	.08	.06	0	.09	.08	0	.04
3.......	47	0	.03	0		.01	0	.02		0	
4.......	40	0		0		.01	0	.02	.01	0	.01
5.......	40	0	.03	0	.08	.05	0	.09	.06	0	.06
6.......	26	0		0		.03	0	.03	.02	0	.01
7.......	54	0	.04	0	.04	.03	0	.04	.03	0	.02
8.......	40	0	.04	0	.05	.05	0	.05	.04	0	.04
9.......	40	0	.03	0	.08	.06	0	.06	.04	0	.05
10.......	60	0	.05	0	.08	.07	0	.06	.05	0	.05
Acreage-weighted averages:			0.056	0	0.056	0.061	0	0.065	0.047	0	0.043

Table 47.--Endrin residues in soil: Area NMA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m
1.......	58	0	0.04	0		0.03	0	0.03	0.02	0	0.01
2.......	28	0		0			0		.01	0	
3.......	47	0		0			0		.01	0	
4.......	40	0	.02	0.20	0.19	.14	0	.07	.09	0	.05
5.......	40	0.08	.02	.20	.16	.15	0	.14	.13	0	.10
6.......	26	0		0			0			0	
7.......	54	0	.05	0	.02	.03	0	.07	.05	0	.01
8.......	40	.03	.05	.20	.20	.20	0	.13	.15	0	.12
9.......	40	.03	.05	.20	.17	.18	0	.13	.22	0	.12
10.......	60	.04	.02	.20	.13	.18	0	.13	.13	0	.10
Acreage-weighted averages:		0.018	0.027	0.102	0.087	0.095	0	0.074	0.083	0	0.054

Heptachlor was used on every block of NMA before 1965 (more than 4.5 pounds per acre on the average), but was found in soil from only two blocks (table 48). Small amounts of heptachlor epoxide were found in soil from two blocks in the spring and fall of 1965, but was not detected after that.

Small amounts of chlordane were found in NMA soils in 1965 and somewhat larger amounts in 1966 and 1967 (table 49). There is no record, however, of chlordane use. A possible explanation for this is that a fertilizer containing chlordane was used on the five blocks where residues were found and that this was not noted in the use record.

Table 50 shows that toxaphene was used on three blocks of NMA (0.5 pound or less) before 1965. Toxaphene was not recovered from soil, however, until the fall of 1966. Decreasing residues were found also in 1967.

Before 1965, 2,4-D was used on every block of NMA (table 51). Recoveries of 2,4-D were very minor and scattered. It is apparent that persistence of 2,4-D in soil at NMA is short.

Table 48.--Heptachlor/heptachlor epoxide residues in soil: Area NMA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.......	58	6.00		0			0			0	
2.......	28	3.00		0			0			0	
3.......	47	3.00		0			0			0	
4.......	40	6.00		0			0			0	
5.......	40	6.00		0			0			0	
6.......	26	6.00		0			0			0	
7.......	54	3.00	0.08	0	0.05		0			0	
8.......	40	4.11		0			0			0	
9.......	40	4.11		0			0			0	
10.......	60	4.50	.08	0	.04		0			0	
Acreage-weighted averages:		4.549	0.021	0	0.012		0			0	

Table 49.--Chlordane residues in soil: Area NMA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	[1] 1965			[2] 1966			[2] 1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.......	58	0		0			0			0	
2.......	28	0		0			0			0	
3.......	47	0		0			0			0	
4.......	40	0		0		0.69	0	0.50	0.51	0	0.42
5.......	40	0		0	0.02	.32	0	.25	.24	0	.22
6.......	26	0		0			0			0	
7.......	54	0	0.16	0	.05	.59	0	.65	.74	0	.69
8.......	40	0	.06	0	.02	.37	0	.30	.33	0	.35
9.......	40	0	.07	0	.03	.35	0	.43	.38	0	.30
10.......	60	0		0	.03	.43	0	.49	.50	0	.36
Acreage-weighted averages:		0	0.032	0	0.017	0.293	0	0.286	0.296	0	0.255

[1] Residues reported here are gamma chlordane (about 60% of the value of technical chlordane.)
[2] Residues reported here are technical chlordane.

In 1966, four blocks at NMA were treated with 0.31 pound per acre of endosulfan. Analyses of soil from NMA show that small amounts of endosulfan persisted until the fall of 1967 (table 52). In the fall of 1967, endosulfan was detected in soils from two blocks with no known prior use, but both values were small (less than 0.06 p.p.m.).

D. Paired Crop and Soil Analyses

Area NMA was originally selected because sugar beets was one of the principal crops. There was an interest in investigating the translocation of pesticides from the soil into root crops (sugar beets at NMA). During the course of monitoring activity at NMA, however, sugar beets were not included in the rotation. For that reason, crop and soil samples were collected from the pair area, NMB, located in the same vicinity as NMA. Analyses of those samples are included in this report.

Table 50.--Toxaphene[1] residues in soil: Area NMA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	Amount applied in 1965	1966		1967		
				Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	Lb./acre	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.........	58	0	0	0			0	
2.........	28	0	0	0			0	
3.........	47	0	0	0			0	
4.........	40	0	0	0			0	
5.........	40	0	0	0	0.41	0.43	0	0.49
6.........	26	0	0	0			0	
7.........	54	0	0	0			0	
8.........	40	0.38	0	0	.82	.46	0	.18
9.........	40	.38	0	0	.99	.59	0	.31
10.........	60	.50	0	0	2.68	.72	0	.38
Acreage-weighted averages:		0.139	0	0	0.576	0.236	0	0.143

[1] 1965 and spring 1966 data unreportable due to sulfur interference.

Table 51.--2,4-D residues in soil: Area NMA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.......	58	1.13	[1] 0.37	0.38			0			0.25	0.12
2.......	28	1.88		0			0			.25	.11
3.......	47	1.88		0			0			.25	.02
4.......	40	2.25		0			0			0	
5.......	40	1.88		0			0			0	
6.......	26	1.50		.33			0			.25	.11
7.......	54	1.88	.84	.33			0			.25	
8.......	40	1.45		0			0			0	
9.......	40	1.45		0			0			0	
10.......	60	1.32		0			0			0	
Acreage-weighted averages:		1.634	0.154	0.112			0			0.123	0.032

[1] Sample collected after application.

The crops sampled at NMA included barley, wheat, and potatoes. Analyses data for these samples and their companion soil samples are listed in table 53.

In all of the soil samples taken with crop samples, DDT was found in amounts ranging from 0.06 to 1.15 p.p.m. Analysis of crop plant material indicates that DDT was found in less than half of those samples and at generally low levels. One sample of potato vines did, however, contain 22.21 p.p.m. of DDT. This rather high level resulted from a foliage application and not from translocation.

A few samples of barley and wheat straw also had residues of DDT, but the amounts found were all less than 0.25 p.p.m.

No residues were detected in grain or potato samples.

Table 52.--Endosulfan residues in soil: Area NMA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.......	58	0		0			0			0	0.01
2.......	28	0		0			0.31	0.03		0	
3.......	47	0		0			.31	.03	0.01	0	
4.......	40	0		0			0			0	
5.......	40	0		0			0			0	
6.......	26	0		0			.31	.03	.03	0	.01
7.......	54	0		0			.31	.02	.03	0	.01
8.......	40	0		0			0			0	
9.......	40	0		0			0			0	
10.......	60	0		0			0			0	.06
Acreage-weighted averages:		0		0			0.111	0.009	0.007	0	0.012

Other pesticides found in the soil samples were endrin, dieldrin, chlordane, heptachlor epoxide, endosulfan, 2,4-D, toxaphene, and aldrin. Of these pesticides, only endrin (1 sample) and endosulfan (2 samples) were detected in crop plant samples.

The paired crop and soil data from Area NMB are listed in table 54. Crops sampled in that area were sugar beets, potatoes, barley, and wheat.

As in Area NMA, DDT was found in all of the companion soil samples at NMB. Endrin was found in all but one soil sample, dieldrin was found in the 1966 and 1967 soil samples, and toxaphene was found in the 1966 soil samples.

The analyses of crop plant samples indicate that small amounts of DDT were found in sugar beet tops, and 8.19 p.p.m. were found in potato vines in 1965. Here again this high level was probably due to a foliage application and not from translocation.

The only other pesticide residues found in crop plant samples from NMB were endrin and endosulfan in potato vines in 1965.

The sample of sugar beets collected in 1966 was the only sample of the crop itself found to contain a residue. That sample contained less than 0.01 p.p.m. of DDT, which probably was translocated from the soil because no DDT was used on that particular sugar beet crop.

E. Water Analyses

The only type of water samples collected at NMA were of quick-runoff water. The analytical results for these samples are shown in table 55.

Pesticide residues were detected in two out of the 21 samples collected. Small amounts of endrin (less than 1 p.p.b.) were found in both samples, and heptachlor epoxide was found in one sample.

F. Aquatic and Terrestrial Organism Analyses

Aquatic organisms were not available at NMA, but they were at NMB. Residue data for aquatic and terrestrial organisms collected at NMB in 1965 are included in this report.

The organisms sampled at NMA were mice, voles, shrews, ground squirrels, gophers, and nestlings and eggs of one species of bird. Residue data for these samples are listed in table 56.

Table 53.--Pesticide residues in paired crop and soil samples: Area NMA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Year and crop	Block	Amount applied: DDT	Endrin	2,4-D	VAM	DNBP	MCPA	Endosulfan	Thimet	Zineb	Maleic hydrazide	Soil analyses: DDT	Endrin	Dieldrin
1965		Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	P.p.m.	P.p.m.	P.p.m.
Barley...	7			0.33								0.19	0.02	0.03
Wheat....	1			.38								.41		.21
Potatoes.	4	0.50	0.20									.42	.43	
Potatoes.	8	1.00	.20		1.46	1.25						1.15	.38	.02
Potatoes.	10	.50	.20		1.46	.63						.17	.25	.03
1966														
Barley...	4						0.38					.24	.15	.01
Wheat....	10						.38					.30	.13	.05
Potatoes.	7	.63						0.31				.52	.10	.04
Potatoes.	7	.63						.31				.58	.09	.21
1967														
Wheat....	1			.25								.16	.01	.11
Wheat....	2			.25								.30		.07
Wheat....	3			.25								.43		
Potatoes.	4								1.50	2.40	3.00	.06	.07	.01
Potatoes.	5								1.50	2.40	3.00	.26	.13	.08
Wheat....	6			.25								.38		
Wheat....	7			.25								.42	.04	.02
Potatoes.	8								1.50	2.40		.87	.14	.01
Potatoes.	9								1.50	2.40	3.00	.54	.09	.04
Potatoes.	10								1.50	2.40	3.00	.22	.08	.03

Year and crop	Block	Soil analyses--Continued: Chlordane	Heptachlor	Endosulfan	Toxaphene	Aldrin	Crop plant analyses: DDT	Endrin	Endosulfan	Crop analyses: DDT	Endrin
1965		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Barley..	7	0.03	0.03								
Wheat...	1										
Potatoes	4										
Potatoes	8						22.21	0.11			
Potatoes	10	.06	.06				3.02		0.01		
1966											
Barley..	4	.65					.15				
Wheat...	10	.96					.20				
Potatoes	7	.59		0.05			1.12		.13		
Potatoes	7	.82					--	--	--		
1967											
Wheat...	1					0.01	.08				
Wheat...	2						.06				
Wheat...	3						.11				
Potatoes	4	.37									
Potatoes	5	.22			0.50						
Wheat...	6						.07				
Wheat...	7	.54		.01			.15				
Potatoes	8										
Potatoes	9	.94									
Potatoes	10	.69		.01							

As found in the areas previously discussed, the most prevalent pesticides found in terrestrial organisms at NMA were DDT, TDE, and DDE. At least one of these compounds was found in all of the samples but two (harvest mice and pocket gophers). Dieldrin, endrin, and heptachlor epoxide were also found in some of the samples.

All of the residues detected in mice were less than 0.1 p.p.m., and those detected in voles were all less than 0.5 p.p.m. Residues in the ground squirrel samples were generally low, but 0.61 p.p.m. of DDE was found in the 1966 sample, along with 0.31 p.p.m. of heptachlor epoxide.

Table 54.--Pesticide residues in paired crop and soil samples: Area NMB

NOTE: Empty spaces indicate no residues detected.

Year and crop	Block	Amount applied					Soil analyses				Crop plant analyses			Crop analyses
		DDT	Endrin	Endosulfan	2,4-D	Lindane	DDT	Endrin	Dieldrin	Toxaphene	DDT	Endrin	Endosulfan	DDT
1965		Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Potatoes.........	3	1.00	0.30	0.50	0.50		0.82	0.32			8.19	0.52	0.20	
Barley...........	12				.50		.41	.06						
Wheat............	14				.50		.22	.06						
Sugar beets......	15						.14	.02			.07			
Sugar beets......	16					0.01	.35				.04			
1966														
Sugar beets......	8					.0037	.08	.03	0.02	0.61	.02			0.004
1967														
Sugar beets......	10					.0037	.05	.10	.02					
Sugar beets......	11					.0037	.05	.08	.02					

Table 55.--Pesticide residues in quick runoff water in 1965 and 1966: Area NMA

NOTE: Empty spaces indicate no residues detected.

Sampling date	Block	Rainfall[1]	Endrin	Heptachlor epoxide
1965		In.	P.p.m.	P.p.m.
June 28.................	2	1.42		
Sept. 4.................	2	1.45		
Sept. 15................	2	.94		
Sept. 30................	2	1.01		
Oct. 16.................	2	.37		
July 12.................	4	1.94		
Sept. 4.................	4	1.45		
Sept. 15................	4	.94	0.00018	
Sept. 30................	4	1.01		
Oct. 19.................	4	.60		
June 28.................	6	1.42		
July 13.................	6	2.04		
June 28.................	7	1.42		
July 12.................	7	1.94		
Sept. 4.................	7	1.45		
Sept. 30................	7	1.01		
Oct. 19.................	7	.60		
1966				
May 12..................	2	.80		
May 12..................	4	.80		
July 21.................	12	1.67	.00038	0.00014
May 12..................	7	.80		

[1] Rainfall listed was recorded on the sampling date, one day before, or both.

Residues of TDE and DDE exceeding 1.0 p.p.m. were found in the sample of shrews collected in 1965. Residues of those chemicals found in the 1966 sample were relatively high, both exceeding 10.0 p.p.m. Dieldrin was found in both samples (0.23 p.p.m. and 0.35 p.p.m. respectively), and a small amount of endrin (0.03 p.p.m.) was found in the 1966 sample.

A single sample each of nestling birds and bird eggs was collected at NMA in 1966. DDT (0.2 p.p.m.) and dieldrin (0.08 p.p.m.) were found in the birds, but DDE (1.90 p.p.m.) was the only pesticide found in the egg sample. This is lower than residue levels of pesticides found in bird eggs at other areas.

The organisms sampled at NMB in 1965 included fish, crayfish, toads, frogs, mice, voles, and snails. Analyses data for these samples are presented in table 57.

Table 56.--Pesticide residues in terrestrial organisms, birds (nestlings), and bird eggs: Area NMA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Organisms	1965 sampling season					1966 sampling season							1967 sampling season		
	Date of sampling	DDT	TDE	DDE	Dieldrin	Date of sampling	DDT	TDE	DDE	Dieldrin	Endrin	Heptachlor epoxide	Date of sampling	DDT	Dieldrin
		P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.
Zapus hudsonius.......... (meadow jumping mouse)	June 15 to June 19..			0.08	0.04	--	--	--	--	--	--	--	--	--	--
Peromyscus spp........... (white-footed & deer mice)	May 29 to June 19...	0.04	0.01	.04	.01	--	--	--	--	--	--	--	June 15 to June 27..	0.02	
	Oct. 19 to Oct. 29..	.02	.01	.02	.01	--	--	--	--	--	--	--	Sept. 26 to Nov. 1..		
Microtus pennsylvanicus.. (meadow vole)	June 15 to June 16...			.04	.02	June 23 to July 6..			0.03	0.01			June 6 to June 27...	.04	
	Oct. 20 to Oct. 29..	.02	.02	.37		Sept. 27 to Oct. 27			.28				Sept. 27 to Oct. 25.	.05	0.01
Blarina brevicauda....... (shorttail shrew)	Oct. 20 to Oct. 23	.33	1.31	3.28	.23	Sept. 21 to Oct. 21		13.39	11.84	.35	0.03		Sept. 26 to Oct. 30.	.79	.03
Citellus sp.............. (ground squirrels)	May 30 to June 18...			.08	.06	June 22 to July 1..		.08	.61	.08		0.31	--	--	--
Reithrodontomys megalotis (Western harvest mouse)	--	--	--	--	--	Sept. 21 to Oct. 27							--	--	--
Geomys bursarius......... (Plains pocket gopher)	--	--	--	--	--	July 1 to Aug. 4...							--	--	--
Agelaius phoeniceus...... (red-wing blackbird)	--	--	--	--	--	June 23 to July 1..			.20	.08			--	--	--
Eggs...............	--	--	--	--	--	June 30 to July 1..			1.90				--	--	--

Table 57.--Pesticide residues in aquatic and terrestrial organisms: Area NMB

NOTE: Empty spaces indicate no residues detected.

Organisms	Date of sampling	1965 sampling season				
		DDT	TDE	DDE	Dieldrin	Endrin
		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Esox sp. (Northern pike)........	Aug. 16............		0.12	0.10		
Ictalurus sp. (bullheads).......	Aug. 16............		.13		0.02	
Minnows (unident.).............	July 20............			.29		
Crayfish........................	June 25............			.11		
	July 20............		.12	.08		
	Aug. 16............		.08	.05		
	Sept. 16...........		.02	.09		
	Oct. 15............		.04	.07		
Bufo hemiophrys (Dakota toad)...	May 29.............		.24	.51	.08	
Rana p. pipiens.................	May 29.............		.07	.09	.03	
(Northern leopard frog)	June 23............		.12	.20	.02	
	June 23............		.07	.20	.04	
	July 20............		.14	.09	.03	0.23
	July 23............			.09		
	Aug. 18............			.09	.14	
	Aug. 18............			.08		
	Aug. 18............			.11		
	Aug. 18............		.19	.12	.03	
	Sept. 16...........		.17	.16	.10	
	Sept. 16...........		.21	.28	.04	
Peromyscus sp.	May 29 to June 19...	0.16	.04	.15	.04	
(mice)	Oct. 19 to Oct. 29..			.01	.01	
Zapus hudsonius.................	May 29 to June 19...		.01	.18	.04	
(meadow jumping mouse)						
Microtus pennsylvanicus.........	May 29 to June 19...					
(meadow vole)	Oct. 19 to Oct. 29..		.01	.19		
Lymnaea helisoma (snails).......	June 23............					
	July 20............					

The only pesticides detected in the three samples of fish from NMB were TDE (2 samples), DDE (2 samples), and dieldrin (1 sample). The largest residue found was 0.13 p.p.m. of TDE.

DDE was detected in all five of the crayfish samples collected at NMB and TDE was found in four. The levels found, however, were well below 0.25 p.p.m. No other pesticides were found in crayfish at NMB.

Small residues of DDE were found in the single toad sample and in all eleven of the frog samples. TDE and dieldrin were found in several of the samples, and endrin (0.23 p.p.m.) was found in a single frog sample. Members of the DDT complex were found in the mice and voles collected, but residue levels in those organisms did not exceed 0.2 p.p.m.

No residues were detected in the two samples of snails collected at NMB.

V. AREA SMO

A. General Description

Area SMO is located near Grand Bay, Ala. The area, once forested, was cleared for farming in about 1952. Since that time, a variety of crops has been grown at SMO, including corn, small grains, cabbage, watermelon, potatoes, and soybeans. Some pasture is included in the acreage. Large amounts of pesticides have been used on the area to control insect pests and noxious weeds.

In 1964, a 10-acre pond was created at the lower end of SMO. Much of the study area drained into this pond, making it an ideal place for sampling water, sediment, and aquatic organisms.

B. Soil Description

The dominant topsoil at SMO is Tifton fine sandy loam, averaging 9 inches in depth. Under the top layer is a friable clay-loam subsoil extending to clay hardpan about 36 inches below the surface. SMO soils are low in plant nutrients and require heavy fertilization.

In the lower lying areas (cleared and drained swamps), the topsoil is black and 2 to 3 feet deep. Such areas produce very little because of the low moisture-holding capacity of the soil.

Figure 6 is an outline map of SMO. Weather data collected at the area are listed in table 58.

C. Soil Analyses

In spite of the variety of pesticides used at SMO, only four were detected in soil. Those four were combined DDT, dieldrin, heptachlor/heptachlor epoxide, and trifluralin. Since 1952 when SMO was cleared, the following have been used to control various pests:

Before 1965	1965	1966	1967
carbaryl	2,4-D*	captan	2,4-D*
chlordane*	DDT*	2,4-D*	DDT*
DDT*	dieldrin*	DDT*	methyl parathion*
dieldrin*	ethyl parathion*	dieldrin*	nabam
ethyl parathion*	maneb	malathion*	mevinphos
heptachlor*	methyl parathion*	maneb	sodium arsenite
methyl parathion*	nabam	marlate methoxychlor*	trifluralin*
sodium arsenite	sodium arsenite	methyl parathion*	zinc sulfate
zinc sulfate		nabam	
		sodium arsenite	
		zinc sulfate	

*Analyzed for.

Residues of combined DDT (DDT, TDE, and DDE) found in SMO soils are listed in table 59. Before 1965, an average of 20.5 lb. per acre of DDT was used at SMO, and most blocks were treated with DDT each year of the study. Residues were found in about 96% of the samples, and 60 percent contained residues of more than 1.0 p.p.m. The weighted-average residues indicate that residues in fall samples were always larger than those in spring samples. Residue levels decreased during the winter, but with the application of more DDT during the growing season, fall residue levels increased to points above those of the previous fall. Apparently the repeated use of DDT at SMO is resulting in a slight buildup in soil.

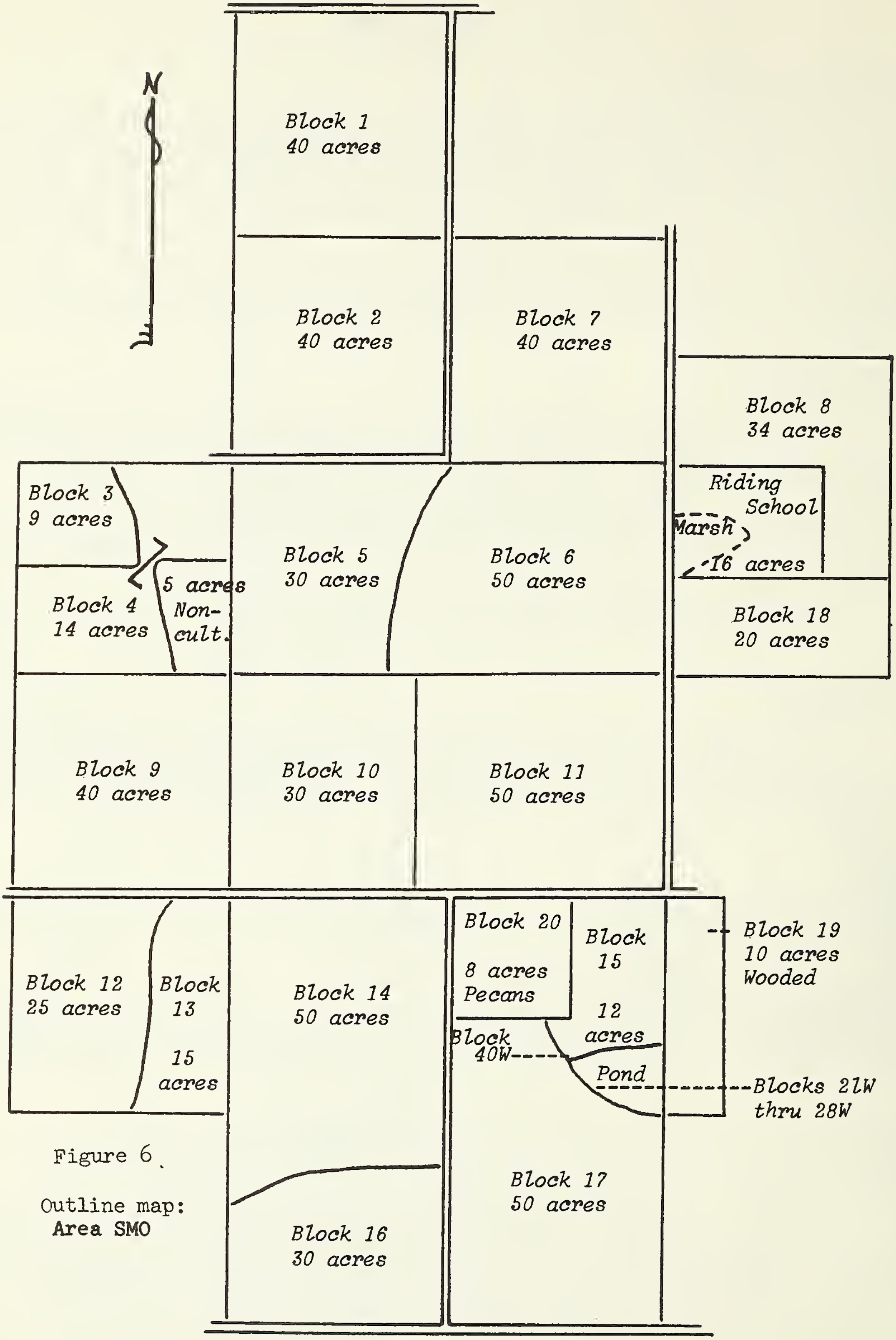

Figure 6.--Outline map: Area SMO

Table 58.--Weather data: Area SMO

Year and month	Temperature		Relative humidity		Total rainfall
	Minimum	Maximum	Minimum	Maximum	
1965:	°F.	°F.	Pct.	Pct.	In.
May	52	91	29	100	3.39
June	63	90	40	100	8.58
July	68	97	46	100	7.72+
Aug	68	94	52	100	9.67+
Sept	52	90	50	100	14.25+
Oct	38	86	28	100	1.90
Nov	32	80	30	98	.60
Dec	29	74	31	99	4.23
1966:					
Jan	11	74	34	98	4.60
Feb	26	69	30	100	10.13+
March	32	76	25	98	3.02
April	39	82	20	100	4.17
May	51	90	43	100	3.52
June	52	96	38	99	5.05
July	67	94	46	99	5.48
Aug	60	93	40	98	9.89
Sept	56	91	42	96	4.86
Oct	38	85	28	98	5.47+
Nov	25	83	20	97	1.64+
Dec	26	75	21	94	2.44
1967:					
Jan	29	74	27	95	5.72
Feb	26	73	22	96	5.88
March	38	82	16	93	.69
April	50	86	24	91	2.00
May	53	90	26	94	2.93
June	66	98	34	94	.82
July	62	97	39	94	2.22
Aug	60	94	38	94	18.11
Sept	45	88	30	94	17.94
Oct	38	86	20	94	6.31
Nov	33	78	20	93	0
Dec	28	78	28	94	4.88

Dieldrin was used on certain blocks at SMO for control of white-fringed beetle. The last recorded use was on three blocks in 1966. Residues of dieldrin found in soil (table 60) seem to reflect the use pattern. Although residues of less than 0.1 p.p.m. were found in soil from blocks with no record of dieldrin treatment, the more significant residues were found in blocks with a history of dieldrin usage. In general, it appears that dieldrin residues are decreasing slowly in SMO soils.

Two pounds per acre of heptachlor was used on nine blocks of SMO before 1965 and was not used after that. Some small residues of heptachlor or its epoxide were found in the 1965 spring and fall soil samples (table 61). As indicated in Area NMA, heptachlor does not persist in soil for any length of time.

The trifluralin residues found in SMO soils are shown in table 62. That chemical was not used at SMO until 1967. Residues were found only in soil from treated blocks and were all less than 0.1 p.p.m.

D. Paired Crop and Soil Analyses

The paired crop and soil data are presented in table 64. The crops sampled at SMO included cabbage, potatoes, soybeans, wheat, watermelon, and corn.

Table 59.--Combined DDT residues in soil: Area SMO

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.......	40	39.11	2.48	1.75	3.30	2.64	3.50	4.04	3.66	1.50	4.00
2.......	40	39.10	2.69	1.63	4.46	2.33	3.50	5.98	2.96	3.94	5.95
3.......	9	2.00	.08	.75	.70	.16	1.00	.55	.33	1.00	1.12
4.......	14	0		.75	1.33	.30	1.00	.64	.43	1.00	1.27
5.......	30	8.33	.68	0	.25	.15	3.50	2.65	1.88	5.00	3.84
6.......	50	5.00	1.43	0	.61	.28	3.50	2.14	1.60	5.00	3.21
7.......	40	11.02	.16	.75	.72	.16	0	.42	.20	0	.27
8.......	34	0		0	.06		0		.05	0	.04
9.......	40	9.57	2.70	1.84	3.62	2.03	4.00	3.66	3.03	1.09	4.31
10.......	30	23.63	2.38	2.45	3.57	1.97	2.83	4.24	3.15	1.60	4.79
11.......	50	36.80	3.36	2.40	3.32	3.49	4.30	4.46	4.08	1.34	5.49
12.......	25	20.20	2.33	1.00	3.69	2.16	0	2.96	2.80	1.00	3.04
13.......	15	18.66	1.36	1.50	1.30	.87	2.00	1.24	1.42	1.00	1.60
14.......	50	38.80	2.88	.99	2.84	3.07	2.00	2.83	2.52	0	3.34
15.......	12	54.10	3.63	2.50	3.99	3.06	2.00	4.05	3.42	0	3.91
16.......	30	5.32	.33	.27	.71	.31	0	.28	.35	1.00	.64
17.......	50	19.65	.70	.38	.67	.62	.12	.63	.56	1.00	.78
18.......	20	27.00	3.05	0	3.04	2.01	3.50	3.75	2.25	5.00	4.18
19.......	10	0	.11	0	.13		0	.08	.08	0	.09
Acreage-weighted averages:		20.501	1.743	1.025	2.106	1.497	2.161	2.569	2.007	1.730	2.990

Table 60.--Dieldrin residues in soil: Area SMO

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1......	40	6.00		0	0.84	1.04	0	0.73	0.72	0	0.82
2......	40	4.00		0	1.07	1.00	0	.98	.47	0	.62
3......	9	0		0			0	.01		0	
4......	14	0		0			0	.03		0	
5......	30	2.00	0.34	[1] 2.00	.49	1.48	0	.91	.65	0	.72
6......	50	2.00	.32	[1] 1.20	.58	1.47	0	1.04	.86	0	.67
7......	40	0		0			0	.02		0	.01
8......	34	0		0			0		.01	0	
9......	40	0		0		1.23	[2] 2.00	.73	.44	0	.44
10......	30	0		0		1.98	[2] 2.00	.87	.40	0	.70
11......	50	0		0			2.00	.50	.23	0	.23
12......	25	0		0			0	.01	.07	0	
13......	15	0		0			0		.01	0	
14......	50	0		0			0		.01	0	
15......	12	0		0			0			0	
16......	30	0		0		.02	0		.01	0	.01
17......	50	0		0			0		.01	0	
18......	20	2.00	1.10	0	.97	.81	0	.52	.42	0	.49
19......	10			0			0		.01	0	
Acreage-weighted averages:		1.019	0.082	0.204	0.237	0.552	0.407	0.407	0.277	0	.294

[1] Applied after fall samples were collected.
[2] Applied before spring samples were collected.

Table 61.--Heptachlor/heptachlor epoxide residues in soil: Area SMO

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1......	40	0		0			0			0	
2......	40	0		0			0			0	
3......	9	0		0			0			0	
4......	14	0	[1] 0.03	0		[1] 0.04	0			0	
5......	30	0		0			0			0	
6......	50	0		0			0			0	
7......	40	0		0			0			0	
8......	34	0		0	0.01		0			0	
9......	40	2.00	.03	0	.06		0			0	
10......	30	2.00	.02	0	.05		0			0	
11......	50	2.00	.05	0	.10		0			0	
12......	25	2.00	.02	0	.05		0			0	
13......	15	2.00	.01	0			0			0	
14......	50	2.00	.05	0	.05		0			0	
15......	12	2.00	.07	0	.08		0			0	
16......	30	2.00		0			0			0	
17......	50	2.00	.01	0	.02		0			0	
18......	20	0		0			0			0	
19......	10	0		0			0			0	
Acreage-weighted averages:		1.026	0.016	0	0.025	0.001	0			0	

[1] Due to heptachlor in chlordane.

Table 62.--Trifluralin residues in soil: Area SMO

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1......	40	0		0			0			0	
2......	40	0		0			0			0	
3......	9	0		0			0			0	
4......	14	0		0			0			0	
5......	30	0		0			0			0	
6......	50	0		0			0			0	
7......	40	0		0			0			0	
8......	34	0		0			0			0	
9......	40	0		0			0			0	
10......	30	0		0			0			0.16	0.01
11......	50	0		0			0			.56	.05
12......	25	0		0			0			1.00	.08
13......	15	0		0			0			0	
14......	50	0		0			0			0	
15......	12	0		0			0			0	
16......	30	0		0			0			1.00	.06
17......	50	0		0			0			1.80	.05
18......	20	0		0			0			0	
19......	10	0		0			0			0	
Acreage-weighted averages:		0		0			0			0.302	0.015

Table 63.--Chlordane residues in soil: Area SMO

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965 Spring	1965 Amount applied	1965 Fall	1966 Spring	1966 Amount applied	1966 Fall	1967 Spring	1967 Amount applied	1967 Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1......	40	0		0			0			0	
2......	40	0		0			0			0	
3......	9	0		0			0			0	
4......	14	0	0.71	1.00	0.27	0.29	0	0.33	0.14	0	0.19
5......	30	0		0			0			0	
6......	50	0		0			0			0	
7......	40	0		0			0			0	
8......	34	0		0			0			0	
9......	40	0		0			0	.29	.09	0	.20
10......	30	0		0			0	.24	.06	0	.14
11......	50	0		0		.38	0	.26	.12	0	.18
12......	25	0		0		.21	0	.21	.09	0	.11
13......	15	0		0		.11	0	.07	.03	0	.05
14......	50	0		0			0	.28	.12	0	.19
15......	12	0		0		.38	0	.29	.12	0	.18
16......	30	0		0			0			0	.03
17......	50	0		0		.16	0	.06	.05	0	.06
18......	20	0		0			0			0	
19......	10	0		0			0			0	
Acreage-weighted averages:		0	0.017	0.024	0.006	0.072	0	0.107	0.044	0	0.07

Most of the crops sampled had been treated with DDT in amounts ranging from 0.75 to 4.00 lb/A. Other pesticides used included methyl parathion, 2,4-D, and mevinphos.

Residues of DDT were found in all the companion soil samples but one, and several were larger than 5 p.p.m. The average DDT residue was 3.25 p.p.m.

Many of the concomitant soil samples also contained residues of dieldrin ranging from 0.02 to 1.24 p.p.m., even though that chemical was not used on any crop sampled.

It is interesting to note that soil from the cabbage field sampled in 1965 contained less than 0.1 p.p.m. of endrin. That material had reportedly never been used at SMO on any block. The source of this endrin could possibly be cross-contamination of some other pesticide that was applied.

Other pesticides found in the concomitant soil samples were aldrin, chlordane (table 63), heptachlor (and its epoxide) (table 61), methyl parathion, and trifluralin (table 62). However, all these were relatively minor and somewhat isolated residues.

In the crop plant analyses, DDT and dieldrin exclusively were found, with DDT present in all but one sample. Many of the residues found in crop plant samples were relatively high and were apparently due to a foliage application.

On the other hand, a large proportion of the crops themselves were found to contain residues of DDT and dieldrin, particularly in 1966 and 1967. Of these residues, it is conceivable that DDT in soybeans resulted from the foliage applications previously mentioned, but the DDT found in potato tubers was probably the result of translocation from the soil. The dieldrin found in the crop portion of the sample was also apparently due to translocation.

Table 64.--Pesticide residues in paired crop and soil samples: Area SMO

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Crop	Block	Amount applied									Soil analyses	
		DDT	Nabam	Zinc sulfate	Phosdrin	Methyl parathion	Dithane M-45	Sodium arsenite	2,4-D	Malathion	DDT	Endrin
		Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	P.p.m.	P.p.m.	P.p.m.
1965												
Cabbage	3					1.00					0.10	0.10
Potatoes	11	1.00					2.00				4.24	
Potatoes	15	1.00					3.00				5.19	
Soybeans	15	1.50				.76					4.99	
Soybeans	17	.75				.38					.82	
Wheat	1								0.25		3.48	
Watermelon	4											
1966												
Cabbage	4					1.00					.52	
Potatoes	1	1.00	8.75	3.75					.25		2.44	
Potatoes	11	1.00					4.80	4.00			3.55	
Soybeans	1	2.50								1.50	5.77	
Soybeans	2	2.50								1.50	5.66	
Soybeans	3	1.00								.25	.68	
Soybeans	4	1.00								.25	.93	
Soybeans	5	2.50								1.50	4.68	
Soybeans	6	2.50								1.50	3.36	
Soybeans	9	4.00								1.75	4.21	
Soybeans	10	2.00								.75	4.23	
Soybeans	11	3.60				1.55					6.04	
Soybeans	15	2.00				1.00					3.88	
Corn	17										.59	
1967												
Soybeans	1	2.00	9.75								4.29	
Potatoes	1	1.00		4.50							3.53	
Potatoes	2	1.00	11.50	5.25							5.71	
Soybeans	2	2.00									5.26	
Cabbage	3				4.00	4.00						
Soybeans	3	1.00				.50					.68	
Cabbage	4				6.00	4.00					--	--
Soybeans	4	1.00				.50					.77	
Potatoes	5	1.00	11.50	5.25							4.25	
Soybeans	5	4.00				1.00					4.39	
Potatoes	6	1.00	11.50								2.22	
Soybeans	6	4.00				1.00					2.11	
Corn	7										.19	
Potatoes	9	.75					8.00				2.91	
Soybeans	9	1.00				.50					3.78	
Potatoes	10	.75					8.00	4.00			3.69	
	10										3.48	
Soybeans	10	1.00				.50					5.28	
Potatoes	11	.75					8.00	4.00			5.38	
	11										4.96	
Soybeans	11	1.00				.50					5.28	
Soybeans	12	1.00				.38					3.68	
Corn	13	1.00				.38					1.37	
Corn	14										2.02	
Corn	15										2.64	
Soybeans	16	1.00				.38					.62	
Soybeans	17	1.00				.38					.75	
Potatoes	18	1.00	11.50	5.25							4.38	
Soybeans	18	4.00				1.00					3.93	

Table 64.--Pesticide residues in paired crop and soil samples: Area SMO--Continued

Crop	Block	Soil analyses: Chlordane	Soil analyses: Dieldrin	Soil analyses: Heptachlor/heptachlor epoxide	Soil analyses: Aldrin	Soil analyses: Trifluralin	Crop plant analyses: DDT	Crop plant analyses: TDE	Crop plant analyses: Dieldrin	Crop analyses: DDT	Crop analyses: Endrin	Crop analyses: Dieldrin
		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
1965												
Cabbage	3						--	--	--	0.04	0.07	
Potatoes	11			0.06			6.61					
Potatoes	15			.09			6.70					
Soybeans	15			.10			2.15					
Soybeans	17			.02			1.39	0.04				
Wheat	1		1.15		0.05		.04			.02		
Watermelon	4	1.30		.08								
1966												
Cabbage	4	.06					--	--	--			
Potatoes	1		1.24				.24		0.07	.01		0.02
Potatoes	11		.79				.45			.01		.01
Soybeans	1		.88				23.64			.25	.002	.03
Soybeans	2		.84				22.39			.28		.03
Soybeans	3		.02				2.86			.08		.01
Soybeans	4	.40	.02				2.19			.06		.01
Soybeans	5		.92				30.39			.33		.05
Soybeans	6		.96				28.18			.49		.12
Soybeans	9	.34	.79				6.39			.15		.03
Soybeans	10	.24	1.03				5.87			.11		.04
Soybeans	11	.21	.84				6.36			.12		.03
Soybeans	15	.19					1.94			.14	.02	.02
Corn	17	.10	.03	.01			3.93			.01		
1967												
Soybeans	1		.83				4.57		.03	.04		.02
Potatoes	1		.43				.23		.04	.02		.05
Potatoes	2		.62				.27		.05	.03		.04
Soybeans	2		.65				2.62		.02	.03		.01
Cabbage	3						--	--	--			
Soybeans	3						2.29					
Cabbage	4	--	--	--	--	--	--	--	--			
Soybeans	4	.28					2.66			.002		.01
Potatoes	5		.54				.06			--	--	--
Soybeans	5		.77				3.13		.03	.04		.02
Potatoes	6		.89				.08		.07	--	--	--
Soybeans	6		.69				3.55		.04	.04		.01
Corn	7		.09				1.45		.02			
Potatoes	9		.36				[1]15.46			--	--	--
Soybeans	9	.23	.28				1.07		.01	.02		.01
Potatoes	10		.49				5.04		.05	--	--	--
	10		.51				--	--	--	.03		.03
Soybeans	10	.41	.63				1.14		.02	.01		.01
Potatoes	11		.39				[1]17.79			--	--	--
	11		.39				--	--	--	.03		.03
Soybeans	11	.15	.60				1.98		.03	.02		.01
Soybeans	12	.12				0.08	1.02		.03	.05		
Corn	13	.05					8.04		.01			
Corn	14	.14					.85		.02			
Corn	15	.17					2.83					
Soybeans	16					.14	1.34					
Soybeans	17	.11	.02			.06	1.89			.01		
Potatoes	18		.58				.10			--	--	--
Soybeans	18		.55				3.97		.01	.03		.01

[1] High DDT residue on potato vines due to 2-week interval between treatment and sampling.

E. Water and Sediment Analyses

Water and sediment were collected from two contained surface sources at SMO. One was the manmade pond previously mentioned, and the other was a wide ditch just above the pond. The former was designated as blocks 21W to 28W (samples were collected from eight points) and the latter was designated as block 40W.

Pesticide residues found in water and sediment from the pond at SMO are listed in table 65. Once again, members of the DDT complex were most frequently found in sediment. Only one residue, however, exceeded 1 p.p.m. DDT complex residues in water were not common, and of those found, very few were over 0.1 p.p.b.

Dieldrin residues in water and sediment from the pond at SMO contrasted with findings in other areas where contained surface water was sampled. Dieldrin was the most prevalent chemical detected in water, particularly in 1966 and 1967. A higher proportion of these residues exceeded 0.1 p.p.b. than of the DDT complex residues, but still none exceeded 0.5 p.p.b. Dieldrin residues in sediment were found in most of the 1966 and 1967 samples, but were generally much smaller than residues of the DDT complex.

Other pesticides detected in water and sediment from the pond at SMO were chlordane, endrin, heptachlor epoxide, triflurarin, and aldrin (in one water sample). These pesticides were found in a very few samples and were generally very small (0.01 or 0.02 p.p.b. in water and less than 0.10 p.p.m. in sediment).

Table 66 is a list of pesticide residues found in the ditch (block 40W) above the pond at SMO. The ditch caught much of the sediment from drainage water (behind a concrete wall) before it reached the larger pond.

Residues of TDE, DDE, and dieldrin were found in nearly all of the sediment samples, but dieldrin was the most frequently detected pesticide in the water. Residue levels in sediment from the ditch were generally much higher than the levels in sediment from the pond. Residue levels in water from the two sources did not appear to differ greatly in magnitude.

Other pesticides found in water or sediment from block 40W were the same as those found in the pond, i.e., chlordane, trifluralin, heptachlor epoxide, and aldrin. Here again, these chemicals were found infrequently and in small amounts.

Quick-runoff water was collected at two points at SMO: Block 40W and a sump that collected water in block 20 (a pecan grove above block 40W). Residue data for water and sediment samples taken at both points are presented in table 67.

The residue picture in quick-runoff water appears to reflect that found in the contained surface sources. Dieldrin was the most frequently detected pesticide in water. Out of the few sediment samples taken with quick-runoff water, only a few were found to contain pesticides (primarily TDE and DDE). The minor pesticides found in quick-runoff water were heptachlor epoxide, trifluralin, methyl parathion, and endrin.

F. Aquatic and Terrestrial Organism Analyses

All of the aquatic organisms sampled at SMO were taken from the previously described pond. Samples were taken of fish, crayfish, frogs, tadpoles, algae, and plankton (table 68).

As reported for other areas, members of the DDT complex and dieldrin were the most significant pesticides detected in fish. In this case, they were almost exclusively present. The only other material found in fish was chlordane in relatively few samples.

Table 65.--Pesticide residues in contained surface water[1] and sediment in 1965, 1966, and 1967: Area SMO

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Sampling date	Rainfall	DDT		TDE		DDE		Dieldrin		Chlordane		Endrin		Heptachlor/ heptachlor epoxide		Trifluralin		Aldrin	
		Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment
1965	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Mar. 31....	--		0.71				0.17												
Apr. 15....	--		.16				.13								0.02				
Apr. 30....			.14		0.04		.07												
May 14.....			.05		.02		.02								.01				
May 26 & 27			.12		.04		.09												
June 7.....	3.20		.15	0.00011	.03	0.00002	.04		0.01										
June 24....			.08		.01		.02												
July 8.....	.07				.11	.00003	.10												
July 23....																			
July 28....	1.43				.10		.09												
Aug. 5.....	.77				.12		.11												
Aug. 20....	3.20	0.00024	.02	.00022	.11		.11						0.02		.01				
Sept. 3....	1.57	.00003	.03	.00005	.11	.00004	.09	0.00001		0.00007		0.00001							
Sept. 17...	.31		.03		.10		.04		.01										
Oct. 1.....	9.31		.96		.31		.09		.01										
Oct. 14....			.03		.15		.06		.01										
Oct. 28....			.06		.17		.05		.01										
Nov. 15....			.02		.10		.07												
Nov. 24....			--		--		--	.00005	--		--		--		--		--		--
Dec. 21....	2.45		.07		.12		.16												
1966																			
Feb. 21....			.08		.18		.09		.02										
Mar. 23....	.06		.08		.15		.16	.00018	.06										
Apr. 21....		.00011	.07	.00012	.12		.10	.00036	.02										
May 5......			.01		.10		.04	.00011	.01										
May 20.....			.07		.15		.07	.00008	.02										
June 2.....			.04		.27		.10	.00012	.06										
June 17....	3.88		.02		.18		.07	.00010	.04										
July 1.....			.05		.23		.06	.00008	.05										
July 6.....	2.11		--		--		--	.00008	--		--		--		--		--		--
July 15....	1.07		.02		.19		.06	.00009	.03										
July 28....					.16		.10	.00016	.01			.00002							
Aug. 11....	4.48		.02		.11		.10	.00012	.03										
Aug. 25....			.01		.19		.07	.00009	.01										
Sept. 8....	.40		.02		.23		.11	.00009	.01										
Sept. 21...	.70		.02		.26		.11	.00006	.02										
Oct. 6.....			.04	.00004	.69		.15	.00007	.06										
Nov. 18....					.17		.11	.00005											
Dec. 14....					.16		.11	.00003											
1967																			
Jan. 17....					.17		.08	.00013											
Feb. 14....		.00008		.00002	.10	.00002	.07	.00010	.01					0.00001					
Mar. 21 & 22					.37		.22		.06										
Apr. 7......					.22		.18		.06										
Apr. 24....			.11		.68		.29		.14										
May 10.....				.00003	.42	.00002	.28	.00005	.05										
May 25.....		.00021	.12	.00004	1.23	.00004	.47	.00006	.10		0.07								
June 15....			.06	.00002	.98	.00001	.62	.00004	.10		.06								
June 28....			.11	.00001	.95		.73	.00002	.18		.04								
July 13....					.39		.24	.00004	.06										
July 26....		.00006		.00020	.50		.28	.00004	.08										
Aug. 10....					.36		.22	.00006	.06										
Aug. 25....	3.45	.00012			.02	.00005	.01	.00005											
Sept. 7....	17.64	.00041			.59	.00006	.43	.00003	.07										
Sept. 20...				.00005	.05	.00002	.06	.00006	.01								0.00001	0.00001	
Oct. 9.....	.25			.00005	.15	.00001	.11	.00006	.02								.00001		
Oct. 18....	1.67			.00004	.61	.00001	.38	.00005	.06								.00001		
Nov. 27....			.03	.00002	.80		.36	.00003	.12										

[1] Block 21W - 28W.

Table 66.--Pesticide residues in contained surface water[1] and in sediment in 1966 and 1967: Area SMO

NOTE: Empty spaces indicate no residues detected.

Sampling date	Rainfall	DDT		TDE		DDE		Dieldrin		Chlordane		Trifluralin		Heptachlor/ heptachlor epoxide		Aldrin	
		Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment
1966	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Aug. 11......	4.48							0.00022									
Aug. 25......				0.00010	0.08			.00011									
Sept. 8......	.40		0.14	.00010	.16		0.09	.00010	0.07								
Sept. 21.....	.70	0.00008	.10	.00049	.53		.15	.00032	.10								
Oct. 6.......			.19	.00010	1.99		.34	.00010	.18								
Nov. 18......					.83		.36		.24								
Dec. 14......					2.13		.96	.00007	.74								
1967																	
Jan. 17......			.24		1.94		.81	.00011	.52								
Feb. 14......		.00004			1.15		.41	.00007	.26								
Mar. 21......					1.33		.50		.28								
Apr. 7.......			.25		1.12		.50		.30								
Apr. 24......					.52		.40		.08								
May 10.......		.00009		.00002	.55	0.00003	.30	.00014	.19					0.00001			
May 25.......			.19	.00008	1.74	.00002	1.00	.00010	.47		0.05						
June 15......			.42	.00040	2.20		.69	.00004	.68		.08						
June 28......			1.36	.00001	4.90		.18	.00003	.53		.14					0.00001	
July 13......			.13		1.11		.44	.00002	.28								
July 26......					.86		.38	.00003	.24								
Aug. 10......			.16		1.37		.53	.00008	.31								
Aug. 25......	3.45	.00049	.17		.67	.00003	.14	.00013	.10								
Sept. 7......	17.64	.00029	.10	.00002	.72		.20	.00005	.11								
Sept. 20.....				.00002	.67		.18	.00007	.09			0.00001					
Oct. 9.......	.25				.75		.19	.00003	.06			.00001					
Oct. 18......	1.67	.00001		.00001	.77		.16	.00003	.12			.00001					
Nov. 27......		.00003			.75	.00001	.22	.00004	.07								

[1] Block 40W.

Table 67.--Pesticide residues in quick runoff water in pond and stream in 1965, 1966, and 1967: Area SMO

NOTE: Empty spaces indicate no residues detected.

Sampling area and date	Rainfall	DDT	TDE	DDE	Dieldrin	Endrin	Heptachlor/ heptachlor epoxide
Pond (blocks 21-28)							
1965	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Aug. 10...........	2.30	0.00187					
Aug. 18...........	.93		0.00008				
Oct. 1............	9.31						
Dec. 20...........	3.16				0.00008		
1966							
Feb. 11...........	1.56				.00016		
Feb. 28...........	5.18		.00007		.00031		
Apr. 19...........	2.34	.00005	.00014		.00041		
June 16...........	3.17	.00001			.00007		
July 6............	2.11				.00008		
Aug. 9............	.96				.00012		
Sept. 13..........	1.57			0.00001	.00007		
Oct. 10...........	3.71				.00007		
1967							
Jan. 3............	3.21				.00006		
Feb. 7............	4.00	.00010	.00002	.00002			0.00001
Aug. 3............	4.94		.00005		.00007		
Aug. 15...........	2.78				.00006		
Sept. 7...........	17.64	.00032	.00007	.00005	.00004		
Oct. 31...........	4.39	.00004	.00003		.00004		
Sump (block 20)							
1965							
Aug. 9............	1.30	.00085	.00208				
Aug. 18...........	.93	.00021	.00036			0.00015	
Oct. 1............	9.31						
Pond (block 40)							
1966							
Aug. 9............	.96				.00045		
Sept. 13..........	1.57	.00011	.00043		.00019	.00005	
Oct. 10...........	3.71				.00015		
1967							
Jan. 3............	3.21				.00019		
Feb. 7............	4.00	.00003			.00006		
Aug. 3............	4.94	.00021			.00054		
Aug. 15...........	2.78	.00038			.00029		
Sept. 7...........	17.64		.00008		.00005		
Oct. 31...........	4.39	.00010			.00005		

Levels of DDT-family pesticides were comparatively high in many of the fish samples, often exceeding 10.0 p.p.m., with one residue of DDT exceeding 50.0 p.p.m. The highest levels were found in 1966[5], with little apparent difference between 1965 and 1967.

Dieldrin was found in nearly every fish sample analyzed. The highest levels were found in 1966 samples, but here the levels in 1967 samples appeared to be substantially higher than those in 1965 samples. Many of the 1966 and 1967 dieldrin residues exceeded 1.0 p.p.m.

[5]As noted in table 68, four of the 1966 samples were of dead fish.

Table 68.--Pesticide residues in aquatic organisms: Area SMO

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Organisms	1965 sampling season								1966 sampling season						1967 sampling season					
	Date of sampling	DDT	TDE	DDE	Dieldrin	Chlordane	Endrin	Heptachlor	Date of sampling	DDT	TDE	DDE	Dieldrin	Chlordane	Date of sampling	DDT	TDE	DDE	Dieldrin	Trifluralin
		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Lepomis sp.......	Apr. 9	0.22	0.03	0.09	0.06	0.53			--	--	--	--	--	--	--	--	--	--	--	--
L. microlophus... (red ear)	Apr. 9	1.24	.02	.09	.04	.26			Aug. 26...........	2.28	2.17	1.34	1.80	8.76	Apr. 6	2.70	1.70	1.83	1.06	
	Apr. 27	.28	.03	.09	.06	.51			Sept. 20..........	3.00	3.86	2.55	3.58		May 10	1.27	.65	.92	.64	
	June 4	5.82	2.70	5.70	.49				Dec. 28...........	2.63	2.24	3.36	1.27		June 14	2.34	1.87	2.35	.72	
	Oct. 26	4.66	3.61	13.26					Midwinter.........	1.42	1.33	1.77	.80		July 13	2.26	1.78	2.81	.27	
	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Aug. 9	1.27	1.32	1.63	.43	
	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Sept. 19	2.23	.89	1.19	.20	
	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Oct. 17	4.23	4.86	4.24	.60	
L. macrochirus... (blue gill)	June 14	17.50	4.20	16.95					Apr. 15...........	5.59	2.48	6.80	4.02		Apr. 6	9.30	5.25	5.44	3.35	
	June 21	7.10	3.20	8.90					Apr. 16 to Apr. 22[1]	7.96	2.91	12.80	2.98		May 10	4.40	2.76	3.58	1.49	
	July 22	3.25	2.68	4.10	.21				Apr. 25 to Apr. 29[1]	9.59	3.40	17.20	3.10		June 14	6.80	3.98	2.48	1.73	
	Aug. 11	6.57	1.86	5.80	.13				May 1 to May 7[1]....	14.90	1.65	12.20	2.20		July 13	9.72	5.04	8.23	1.71	
	Aug. 25	9.90	2.10	7.30	.08				May 16 to May 20[1]..	40.30	5.12	23.10	5.90		Aug. 9	10.40	5.08	8.94	1.34	
	Aug. 30	2.15	1.43	7.38	.16				May 19............	22.70	1.55	17.00	2.60		Sept. 19	11.10	3.83	8.68	1.04	
	Sept. 29	8.30	5.50	14.70	1.10				June 23...........	6.95	.97	2.27	.55	.39	Oct. 17	3.93	2.43	2.76	.79	
	Oct. 26	9.73	6.09	19.28	.43				July 26...........	9.11	1.33	7.32	1.52		--	--	--	--	--	--
	Oct. 29	9.96	3.19	5.69	.29				Sept. 20..........	16.70	7.67	11.10	6.35		--	--	--	--	--	--
	Nov. 23	14.93	5.60	10.16					Oct. 31...........	28.70	10.26	14.06	7.44		--	--	--	--	--	--
	--	--	--	--	--	--	--	--	Dec. 28...........	51.70	17.08	22.20	9.98		--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gambusia sp...... (minnows)	June 14	7.20	.78	5.10	.20				Apr. 19...........	16.51	2.44	4.07	2.41	1.31	Apr. 6	8.60	3.68	5.81	2.18	
	July 30	3.80	2.33	5.55	.19				May 17............	21.98	3.32	5.05	4.02	1.30	May 9	7.89	4.02	5.99	2.21	
	Aug. 11	14.40	4.40	4.05					June 23...........	18.04	1.89	3.38	1.50	.36	June 15	2.16	2.61	2.35	2.04	
	Aug. 25	13.97	5.10	4.90	.13				July 22...........	1.98	2.01	.97	.74	.13	July 13	1.09	1.49	1.42	.64	
	Sept. 28	15.98	7.30	15.01	.33				Aug. 23...........	13.30	4.92	2.10	1.76	.18	Aug. 9	2.16	2.61	2.35	2.04	
	Oct. 28	22.53	9.99	18.93	1.06				Sept. 20..........	15.63	9.16	2.87	2.38	.75	Sept. 13	7.75	1.76	1.93	.60	
	--	--	--	--	--	--	--	--	Oct. 24...........	10.68	7.60	2.16	1.65	.39	Oct. 15	6.42	2.99	3.28	.72	
	--	--	--	--	--	--	--	--	Dec. 27...........	19.12	9.12	3.06	2.05	.64	--	--	--	--	--	--
Ameiurus nebulosus (catfish)	--	--	--	--	--	--	--	--	Aug. 22...........	3.56	1.80	3.54	1.49		Apr. 7	16.10	7.51	12.90	3.95	
	--	--	--	--	--	--	--	--	Sept. 26..........	14.97	8.56	8.24	4.35		May 10	5.52	4.18	2.77	1.56	
	--	--	--	--	--	--	--	--	Dec...............	49.65	20.68	21.72	7.67		June 14	7.89	5.24	8.73	1.35	
	--	--	--	--	--	--	--	--	--	--	--	--	--	--	July 13	6.78	4.79	6.67	.77	
	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Aug. 9	2.23	1.67	2.03	.28	
	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Sept. 18	3.40	2.02	2.14	.52	
	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Oct. 17	5.50	2.71	4.49	.58	
Crayfish.........	June 14	.41	.04	.61					--	--	--	--	--	--	--	--	--	--	--	--
	July 14	.07		.43					--	--	--	--	--	--	--	--	--	--	--	--
	Aug. 25	.98	.13	1.18					--	--	--	--	--	--	--	--	--	--	--	--
	Sept. 27	.47	.09	.78					--	--	--	--	--	--	--	--	--	--	--	--
Frogs............ (unident.)	Sept. 27	6.25	1.60	3.77	.08				--	--	--	--	--	--	--	--	--	--	--	--
Tadpoles......... (unident.)	June 21	.34	.49	.57					Apr. 25...........	2.10	2.15	1.32	.58		Apr. 7	.34	.82	.51	.17	
	July 21	.27	1.17	.72					May 16............	2.13	3.31	2.08	.57		May 9	1.14	4.04	1.73	.48	
	Sept. 28	.41	1.28	1.50					June 13...........	.58	.88	.93	.23		--	--	--	--	--	--
	Nov. 12	.29	1.70	1.77					July 21...........	.34	.56	.93	.25		--	--	--	--	--	--
	--	--	--	--	--	--	--	--	Aug. 25...........	6.60	2.99	1.24	.17		--	--	--	--	--	--
Algae............	June 17	3.85	.71	.44			0.18		Apr. 12...........	.05	.13	.13	.21		June 14	.13	.04	.06	.01	
	July 22	2.82	.73	.27			.12		May 16............	.05	.12	.07	.79		Sept. 13	.43	.63	.41	.11	
	Aug. 25	26.52	3.01	1.78					June 13...........	.05	.05	.04	.02		Oct. 16	.02	.10	.09	.02	
	Sept. 28		.44	.31					July 22...........		.11	.08	.10		--	--	--	--	--	--
	Oct. 28		.20	.09					Aug. 22...........		.44	.09	.07		--	--	--	--	--	--
	--	--	--	--	--	--	--	--	Sept. 19..........		.33	.13	.19		--	--	--	--	--	--
	--	--	--	--	--	--	--	--	Oct. 27...........	.10	.28	.05	.05		--	--	--	--	--	--
Plankton.........	Oct. 12	.89	1.50	1.22	.07			0.04	Apr. 7............	.78	1.38	.53	.71		Apr. 7	.53	.76	.96	.26	
	--	--	--	--	--	--	--	--	May 24............	4.29	2.73	.61	.51		May 9	.50	1.05	.62	.41	
	--	--	--	--	--	--	--	--	Aug. 25...........	.09	3.38	.90	.34		June 15	.08	.83	.34	.32	
	--	--	--	--	--	--	--	--	Sept. 22..........		1.26	.58	.22		July 12		.46	.25	.18	0.26

[1] Acute fish kill--samples were of dead fish.

Crayfish were sampled only in 1965. The residues found were of DDT, TDE, and DDE, with no dieldrin detected. Residue levels were generally low in crayfish, although residues were found in every sample.

Residues of DDT, TDE, and DDE were detected in the single frog sample and in every tadpole sample collected at SMO. Many of these residues were greater than 1.0 p.p.m.

Dieldrin was detected in the frog sample and in all of the tadpole samples except those collected in 1965. These residues ranged from 0.08 to 0.58 p.p.m.

As in the other aquatic organisms sampled at SMO, the algae samples contained the DDT complex and dieldrin; however, endrin was also found (in two 1965 samples). Residue levels were highest in the 1965 samples, with little difference between those collected in 1966 and 1967.

The residues detected in plankton from the pond at SMO seem to be commensurate with those found in the fish samples. The largest residues were found in 1966 samples.

DDT, TDE, DDE, and dieldrin were commonly found in the plankton. In addition, heptachlor epoxide and trifluralin were detected in one sample each.

The terrestrial organisms sampled at SMO were mice, rats, rabbits, earthworms, slugs, snails, and toads (table 69).

The sampling of small mammals at SMO was very limited, with no more than two samples of a species collected in any one year. The residues found were DDT, TDE, DDE, dieldrin, and heptachlor epoxide, with a small chlordane residue in one sample of mice. The residue magnitude appeared to be similar between species, except that no pesticides were found in the single rabbit sample collected. Only five residues (4 DDT and 1 DDE) of those found in small mammals were greater than 1.0 p.p.m.

The only pesticides detected in earthworms, slugs, and snails were the DDT complex and dieldrin. Residue levels were relatively high in all three kinds of organisms, with many greater than 1.0 p.p.m. By far the largest residues were found in terrestrial snails (up to 58.15 p.p.m. of DDT). Nearly all of the dieldrin residues found in snails were more than 1.0 p.p.m., as were those of TDE and DDE.

The three toad samples yielded residues of DDT, TDE, and DDE in amounts ranging from 0.55 to 8.33 p.p.m. Relatively small amounts of dieldrin were found in two of the toad samples.

During the 3 years of monitoring SMO, eleven species of birds were sampled as nestlings (table 70). In 1966 and 1967 samples of eggs were also collected.

As seems to be common among wildlife samples collected at SMO and other places, nearly all of the avian samples were found to contain DDT, TDE, DDE, and dieldrin. Two samples in 1965, one sample in 1966, and nearly all samples in 1967 also contained relatively small amounts of heptachlor epoxide. Residues in bird eggs were much larger than those in nestling birds, as seen in the other areas where birds and eggs were sampled.

Table 69.--Pesticide residues in terrestrial organisms: Area SMO

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Organisms	1965 sampling season						1966 sampling season						1967 sampling season						
	Date of sampling	DDT	TDE	DDE	Dieldrin	Heptachlor epoxide	Date of sampling	DDT	TDE	DDE	Dieldrin	Heptachlor epoxide	Date of sampling	DDT	TDE	DDE	Dieldrin	Chlordane	Heptachlor epoxide
		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Peromyscus gossypinus. (cotton mouse)	May................	0.40	0.03	0.92	0.45		--	--	--	--	--	--	--	--	--	--	--	--	--
Mice.................. (unident.)	--	--	--	--	--	--	Spring...	2.01	0.19	0.87	0.16	0.04	--	--	--	--	--	--	--
	--	--	--	--	--	--	Fall.....	1.61	.09	.17	.03	.01	--	--	--	--	--	--	--
Reithrodontomys humulis (Eastern harvest mouse)	Nov. 1 to Dec. 31..	1.03	.04	.20	.05	.003	--	--	--	--	--	--	Spring...	0.25	0.08	0.27	0.42	0.02	
													Fall.....	.75	.08	.31	.05		0.13
Sigmodon hispidis..... (hispid cotton rat)	May................						--	--	--	--	--	--	Spring...	.08	.03	.06	.02		
	--	--	--	--	--	--	--	--	--	--	--	--	Fall.....	.13	.04	.08	.02		.01
	Nov. 1 to Dec. 31..	.53	.08	.68	.03		--	--	--	--	--	--	--	--	--	--	--	--	--
Neotoma floridana..... (Eastern wood rat)	Nov. 1 to Dec. 31..	2.81	.41	3.54			--	--	--	--	--	--	Spring...	.07	.03	.15	.02		
Sylvilagus floridanus. (rabbit)	--	--	--	--	--	--	--	--	--	--	--	--	Sept. 15.						
Earthworms...........	--	--	--	--	--	--	Apr. 27..	.35	.33	.13	.02		Mar. 6...	3.99	.43	1.48	1.62		
	--	--	--	--	--	--	Fall.....	4.34	1.35	1.15	4.29		Mar. 9...	1.11	.12	.16			
	--	--	--	--	--	--	Fall.....	2.76	.88	.20	.02		--	--	--	--	--	--	--
Gastropods........... (slugs)	July 21...........	6.43	.60	.60	1.70		June 16..	5.39	.28	.42	.91		--	--	--	--	--	--	--
	--	--	--	--	--	--	July 22..	1.58	.06	.37	.71		--	--	--	--	--	--	--
	--	--	--	--	--	--	Oct. 17..	8.09	.59	1.08	.54		--	--	--	--	--	--	--
Terrestrial snails	June 22...........	10.27	.50	.68	1.16		Aug. 22..	10.46	.82	.86	.73		May 24...	13.38	.37	1.77	1.19		
	Aug. 30...........	8.80	1.00	1.10	1.28		Sept. 16.	7.35	.46	.89	.65		June 27..	6.03	.70	1.24	.90		
	Oct. 28...........	21.35	3.33	1.75	2.16		--	--	--	--	--	--	July 20..	12.69	.52	1.35	1.23		
	--	--	--	--	--	--	--	--	--	--	--	--	Aug. 16..	6.11	1.14	1.37	1.08		
	--	--	--	--	--	--	--	--	--	--	--	--	Sept. 14.	58.15	2.81	2.65	.81		
	--	--	--	--	--	--	--	--	--	--	--	--	Oct. 17..	54.06	2.61	2.90	1.45		
Bufo sp.............. (toads)	Apr. 26...........	1.40	.76	2.16			--	--	--	--	--	--	--	--	--	--	--	--	--
	June 18...........	.55	.58	1.67	.05		--	--	--	--	--	--	--	--	--	--	--	--	--
	July 20...........	7.39	1.13	8.33	.28		--	--	--	--	--	--	--	--	--	--	--	--	--

Table 70.--Pesticide residues in birds (nestlings) and bird eggs: Area SMO

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Species	1965 sampling date						1966 sampling date						1967 sampling date						
	Date of sampling	DDT	TDE	DDE	Dieldrin	Heptachlor epoxide	Date of sampling	DDT	TDE	DDE	Dieldrin	Heptachlor epoxide	Date of sampling	DDT	TDE	DDE	Dieldrin	Chlordane	Heptachlor epoxide
		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Cyanocitta cristata... (blue jay)	July 16.	0.37	0.17	0.73			Summer..	0.17	0.07	3.15	0.36		Summer..	0.23	0.02	0.66	0.29		
Eggs...........	--	--	--	--	--	--	Summer..	3.43	.56	15.15	.08		Summer..	.88	.27	6.41	.64		0.08
Toxostoma rufum....... (brown thrasher)	June....	.06	.03	.81	0.13		--	--	--	--	--	--	Summer..	.37	.07	4.35	.39		
Eggs...........	--	--	--	--	--	--	Summer..	5.30	.71	59.45	1.38		Summer..	1.76	.60	15.89	.10		.24
Agelaius phoeniceus... (red wing)	July....	.09	.07	3.10	.26		Summer..	.35	.15	7.55	.54		Summer..	.60	.15	2.98	1.17		.01
Eggs...........	--	--	--	--	--	--	Summer..	1.32	.24	20.81	2.52		Summer..	1.05	.28	54.28	5.94		.46
Mimus p. polyglottus.. (mockingbird)	July 23.			5.06	.13	0.14	Summer..	.16	.03	2.19	.09		Spring..	.25	.01	3.47	.42		.02
Eggs...........	--	--	--	--	--	--	--	--	--	--	--		Summer..	1.78	.42	22.11	.42		.27
Zenaidura macroura.... (mourning dove)	July 28.	.69	.38	2.01	5.00	.15	Summer..	.49	.11	3.22	2.31	1.30	Summer..	.22	.02	.47	1.88		.02
Eggs...........	--	--	--	--	--	--	--	--	--	--	--	--	Summer..	.24	.04	15.00	.10		.03
Tyrannus tyrannus..... (king bird)	July....			.43	.03		--	--	--	--	--	--	--	--	--	--	--	--	--
Grackle...............	--	--	--	--	--	--	--	--	--	--	--	--	Summer..	2.00	.23	7.73	3.47		
Eggs...........	--	--	--	--	--	--	Summer..	1.49	.24	4.85	.90		Summer..	1.80	.35	23.92	3.20		.85
Colinus virgianus..... (bob white)	--	--	--	--	--	--	--	--	--	--	--	--	Summer..						
Eggs...........	--	--	--	--	--	--	--	--	--	--	--	--	Summer..	.74	.16	3.45	4.78		.04
Richmondera cardinalis	--	--	--	--	--	--	--	--	--	--	--	--	Summer..	.13	.03	1.27	.14		.02
Eggs...........	--	--	--	--	--	--	--	--	--	--	--	--	Summer..	1.35	.95	7.87	5.62		.07
Icterus spurius....... (orchard oriole)	--	--	--	--	--	--	--	--	--	--	--	--	Summer..	.18	.03	.58	.01	0.01	
Eggs...........	--	--	--	--	--	--	--	--	--	--	--	--	Summer..	.36	.08	1.16	.19		.01
Columbigallina p..... passerina (ground dove)	--	--	--	--	--	--	--	--	--	--	--	--	Summer..	.38	.08	.72	.35		.03
Eggs...........	--	--	--	--	--	--	--	--	--	--	--	--	Summer..	.52	.18	1.15	1.60		.07

VI. AREA YUA

A. General Description

Area YUA is located near Yuma, Ariz., in the Yuma Valley of the Colorado River. Cotton, vegetables, and cantaloup are the principal crops grown in this valley. At the beginning of the 3-year study at YUA, cotton was grown every year on about half of the study area. Alfalfa, a lettuce-cantaloup rotation, and irrigated pasture made up production on the other half.

In 1966, a change in ownership resulted in cessation of cotton culture at YUA. After that, the entire area (excluding the pastures and alfalfa fields) was used for growing produce, primarily lettuce and cantaloup.

The entire study area is irrigated with river water carried through the valley in large canals. Irrigation water is not reused in that area, but is carried back to the river at the lower end of the valley by large drainage canals. Drainage water enters these canals by seepage from the water table. One main canal and two drainage canals transeet YUA.

Among the areas discussed in this report, YUA is unique (a) in that the annual growing season in 365 days; and (b) because land used for growing produce is left idle in the summer months (only cotton is grown in summer) when farming activity is at a peak in the other study areas. Because of this practice, fall samples were collected at YUA from October through January, and spring samples were collected from March through June. This should be kept in mind while reviewing the analytical data.

The weather data collected at YUA are listed in table 71. Figure 7 is an outline map of the area.

B. Soil Description

The soils at YUA are predominantly loams. They range, in general, from silty clay loam, fine sandy loam, and clay loam in the upper end of the area, to clay loam and silty clay loam in the middle of the area, with clay loam and silty clay at the lower end. Small, localized spots of sand and loam are situated along the northern and eastern sides of the area.

In general, the YUA topsoils have a good water-holding capacity, with relatively rapid to slow intake rates. The subsoils in the area have a generally poor water-holding capacity.

Because of the intensity of farming at YUA and in the absence of a normal fallow period in the rotation, fertilizers are extensively used in crop production.

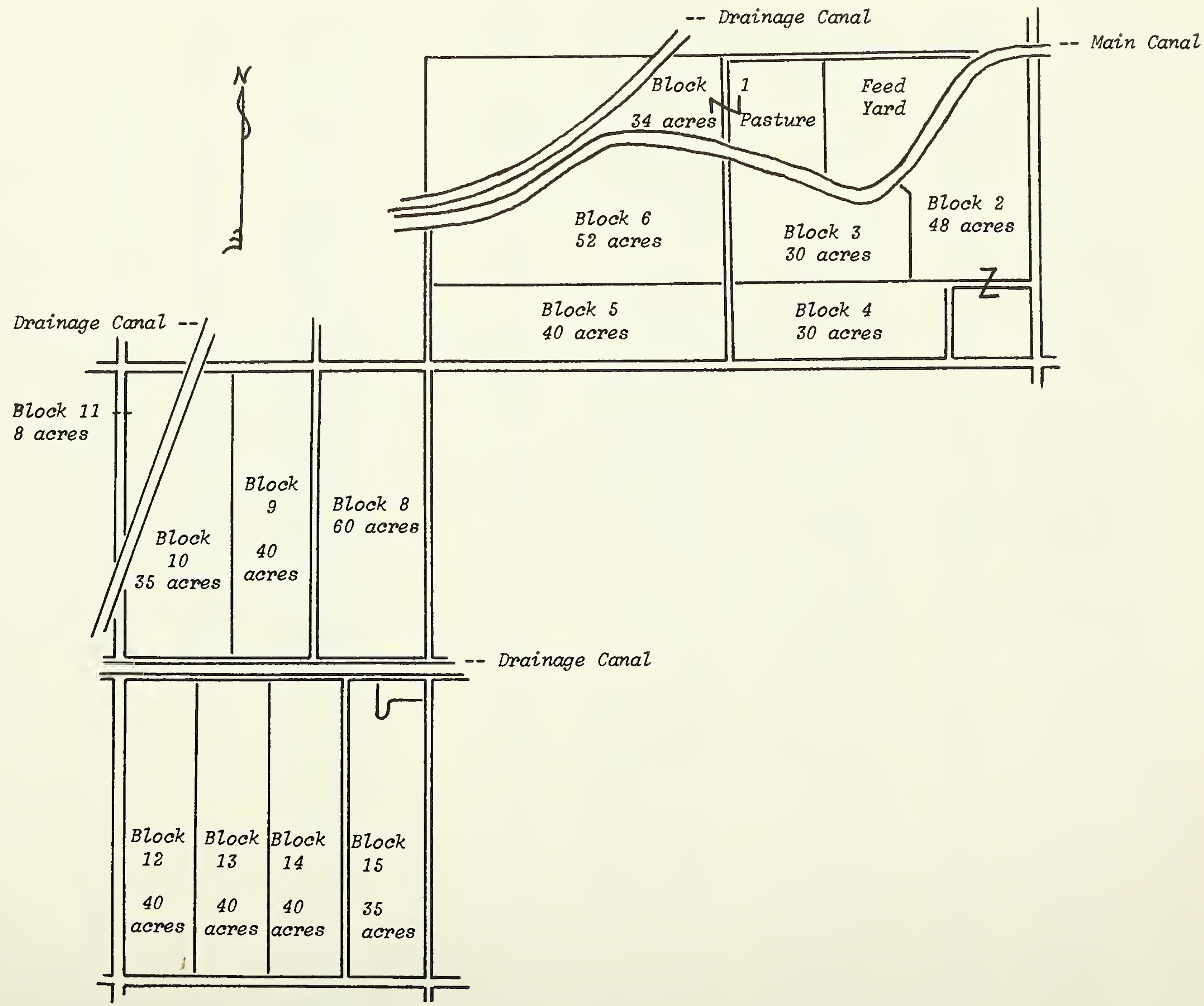

Figure 7.--Outline map: Area YUA

Due to the climate, the intensity of farming, and other reasons, a wide variety of pesticides have been used at YUA. The following is a list of those used before and during the monitoring study:

Before 1965	1965	1966	1967
DDT*	aldrin*	benefin*	benefin*
demeton*	DDT*	DDT*	captan
dicofol	demeton*	dimethoate*	DDT*
dieldrin*	dicofol	dinocap*	dicofol
dinocap*	Dilan*	DNOSBP	dimethoate*
endosulfan*	dimethoate*	endosulfan*	DNOSBP
endrin*	dinocap*	endrin*	endosulfan*
ethyl parathion*	endrin*	ethyl parathion*	endrin*
methyl parathion*	malathion*	fenthion*	ethyl parathion*
mevinphos	Panogen	methyl parathion*	methyl parathion*
Panogen	PCNB*	mevinphos	mevinphos
Perthane*	toxaphene*	MSMA*	MSMA*
Sodium fluosilicate	trifluralin*	oxydemetonmethyl*	oxydemetonmethyl*
thiram		Sodium fluosilicate	Sodium fluosilicate
toxaphene*		sulfur*	toxaphene*
Vegadex		toxaphene*	
zineb		Vegadex	

*Analyzed for.

C. Soil Analyses

The principal pesticides found in soils from YUA were combined DDT, dieldrin, endrin, and toxaphene. Toxaphene and DDT were used to control cotton pests; endrin and dieldrin were used primarily as seed treatments.

Other pesticides found in YUA soils were endosulfan, methyl parathion, and ethyl parathion. These chemicals were used for controlling lettuce pests.

From 2.0 to 6.0 lb/A of DDT were used on 10 blocks of YUA before 1965. Most of the blocks were treated with DDT in amounts ranging from 2.0 to 11.0 lb/A during the succeeding 3 years. The residues of combined DDT (DDT, TDE, and DDE) found in YUA soils are shown in table 72. Residues were found in every block each time they were sampled, with the lone exception of the spring 1966 samples from block 1. The highest levels of combined DDT were found in samples from blocks with a record of treatment and fall residues were larger than spring residues each year. The acreage weighed average residues for each sampling exceeded 1.0 p.p.m. There does not appear, however, to be a significant buildup of DDT in YUA soils.

As previously mentioned, dieldrin usage at YUA was restricted to seed treatments (table 73). The resulting residues in soils were relatively small (only four were 0.1 p.p.m. or larger) and were found in only a few samples in the spring of 1965, spring of 1966, and fall of 1967. Residues of dieldrin were found in most of the 1965 and 1966 fall soil samples and in all but one of the spring 1967 samples but, again, they were low levels.

Table 71.--Weather data: Area YUA

Year and month	Temperature		Relative humidity		Total rainfall
	Minimum	Maximum	Minimum	Maximum	
1965:	°F.	°F.	Pct.	Pct.	In.
Feb	27	86	9	98	0.75
March	31	83	6	98	0
April	45	104	6	98	.72+
May	46	104	14	98	0
June	54	104	10	98	0
July	63	114	18	98	0
Aug	63	112	19	98	0
Sept	46	106	18	99	0
Oct	43	104	16	99	0
Nov	31	92	12	100	.66+
Dec	31	80	20	100	2.11+
1966:					
Jan	26	74	16	99	.28+
Feb	26	78	14	100	.21+
March	31	94	12	99	.01+
April	42	97	10	99	0
May	50	102	14	99	0
June	53	111	20	99	Trace[1]
July	63	111	17	99	.11
Aug	61	110	16	99	.22
Sept	59	111	16	99	.04+
Oct	42	99	14	99	.53
Nov	34	90	20	99	Trace[1]
Dec	27	82	26	100	Trace[1]
1967:					
Jan	27	80	20	99	.23
Feb	30	83	12	100	0
March	34	91	14	98	.07
April	38	88	14	99	0
May	40	104	16	99	0
June	53	110	16	98	0
July	68	114	20	99	.01+
Aug	67	111	20	99	.19
Sept	58	103	14	99	1.52+
Oct	46	97	10	99	0
Nov	39	89	14	100	.94+
Dec	31	75	19	100	.69+
1968:					
Jan	30	74	18	100	Trace[1]

[1] Less than 0.01 inch.

An average of 0.25 lb/A of endrin was used on YUA before 1965, but use of the chemical was not extensive in 1965, 1966, or 1967. Residues of endrin appear to parallel usage in that the largest residues were found where the most endrin was used (table 74).

It should be noted that some endrin did persist until 1967 at least, in soil taken from blocks that were not treated with endrin after 1964. In spite of this persistence, there does not seem to be a buildup of endrin in the two blocks that were treated each year.

As discussed earlier, toxaphene was used in cotton culture and on lettuce at YUA, both before and during the study. The residues detected in soil seem to reflect what was found at other

Table 72.--Combined DDT residues in soil: Area YUA

NOTE: Empty space indicates no residue detected.

Block	Acres	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1......	34	0	0.06	0	0.13		0	0.07	0.07	0	0.17
2......	58	0	1.54	0	2.04	2.68	0	3.56	1.94	11.00	9.88
3......	30	0	1.72	0	1.86	2.21	0	1.16	1.39	6.00	5.10
4......	30	0	1.66	0	3.36	2.55	0	1.81	1.10	6.00	5.13
5......	40	4.00	1.13	0	.63	1.00	0	.84	.67	0	1.02
6......	52	4.00	1.15	0	.95	1.17	0	.68	.64	0	.88
7......	40	0	.11	0	.23	.08	0	.14	.15	0	.14
8......	60	4.00	3.45	2.00	3.54	3.09	9.00	13.73	4.28	0	5.31
9......	40	6.00	2.79	2.00	3.30	3.14	0	2.68	2.48	0	2.60
10......	35	4.00	2.32	2.00	3.99	3.98	0	3.38	2.83	10.00	8.79
11......	8	4.00	2.94	2.00	3.34	3.23	0	2.49	2.45	10.00	7.30
12......	40	2.00	3.18	2.00	4.64	4.30	6.00	13.91	6.14	0	5.66
13......	40	2.00	2.02	2.00	4.26	3.95	6.00	11.58	6.89	0	5.31
14......	40	4.00	2.42	2.00	3.61	3.22	2.50	6.24	4.71	0	3.99
15......	35	4.00	2.14	2.00	3.55	2.67	8.50	8.74	5.42	0	4.20
Acreage-weighted averages:		2.543	1.899	1.024	2.575	2.458	2.436	5.184	2.800	2.454	4.316

Table 73.--Dieldrin residues in soil: Area YUA

NOTE: Empty spaces indicate no residues detected and dashes indicate no information was available.

Block	Acres	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall[1]
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1......	34	0		0			0			0	--
2......	58	0.02		0			0			0	--
3......	30	.04		0			0			0	--
4......	30	.002		0			0			0	--
5......	40	.003		0.001			0.001			0.001	--
6......	52	.003		.001			.001			.001	--
7......	40	0		0			0			.001	
8......	60	.001	0.03	0			.001			.001	--
9......	40	.001		0	.05		.001			.001	--
10......	35	.001		0	.03		.001			.005	--
11......	8			0			.001			.005	--
12......	40	.001	.07	0	.07		.001			.009	--
13......	40	0		0	.04		.001			.005	--
14......	40	0		0	.01		.001			.005	--
15......	35	0	.04	0	.07		.001			.005	--
Acreage-weighted averages:		0.005	0.010	0.0001	0.018		0.001			0.002	

[1] All but one sample unreportable because of an extraneous peak of interference.

study areas (table 75). The residue levels detected were quite large compared with residue levels of other pesticides, but there is apparently no buildup in the soil. On the other hand, repeated application of relatively large amounts of toxaphene seems to maintain these higher levels in the soil.

Table 74.--Endrin residues in soil: Area YUA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1......	34	0		0			0			0	
2......	58	0.21	0.21	0	0.53	0.47	0	0.20	0.10	0	0.25
3......	30	.21	.14	0	.75	.60	0	.18	.11	0	.23
4......	30	.24	.15	0	.83	.73	0	.17	.11	0	.25
5......	40	.31	.32	.03	.17	.18	0.78	.57	.47	0.77	.34
6......	52	.45	.30	.03	.23	.20	.78	.70	.43	.77	.45
7......	40	0		0			0		.01	0	.01
8......	60	.24	.50	0	.17	.11	0	.41	.14	0	.20
9......	40	.27	.65	0	.34	.19	.80	.57	.37	0	.31
10......	35	.21	.32	0	.23	.23	.78	.59	.31	0	.25
11......	8	.17	.80	0	.25	.21	.78	.41	.29	0	.30
12......	40	.41	.60	0	.27	.30	.78	1.00	.41	0	.34
13......	40	.41	.37	0	.45	.17	.78	.90	.40	0	.25
14......	40	.41	.36	0	.33	.19	.78	1.10	.31	0	.19
15......	35	.28	.25	0	.61	.16	0	.22	.15	0	.06
Acreage-weighted averages:		0.265	0.318	0.005	0.334	0.242	0.397	0.482	0.241	0.122	0.232

Table 75.--Toxaphene/Strobane[1] residues in soil: Area YUA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	Amount applied in 1965	1966		1967		
				Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	Lb./acre	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.........	34							
2.........	58				1.81	2.18	9.00	8.34
3.........	30				1.37	1.14	4.00	2.90
4.........	30				1.95	2.03	4.00	2.87
5.........	40				.51	.65		.80
6.........	52				.41	.64		.62
7.........	40							
8.........	60	8.00	4.00	6.00	6.32	4.27		4.53
9.........	40		4.00		2.82	3.30		3.22
10.........	35		4.00		2.60	3.43	9.00	4.19
11.........	8		4.00		3.18	3.37	9.00	7.01
12.........	40	4.00	4.00	4.00	6.32	6.28		7.36
13.........	40	8.00	4.00	4.00	7.21	8.67		6.67
14.........	40	8.00	4.00	2.50	6.68	7.95		6.05
15.........	35	8.00	4.00	6.50	6.94	7.52		4.57
Acreage-weighted averages:		2.680	2.048	1.731	3.275	3.428	1.974	3.930

[1] 1965 and spring 1966 analyses unreportable due to sulfur interference.

Endosulfan residues in YUA soils (table 76) appear to correspond very well to endosulfan use. In addition, there seems to be no buildup at all in the soil. It can be noted that, in spite of a history of endosulfan use on eight blocks of YUA before 1965, no residues were found in the spring 1965 soil samples, and only two samples in the fall contained endosulfan.

Table 76.--Endosulfan residues in soil: Area YUA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1......	34	0		0			0			0	
2......	58	0		0			0			0	
3......	30	0		0			0			0.75	0.38
4......	30	0		0			0			.75	.52
5......	40	0.50		0	0.18		2.25	0.81	0.33	.75	.26
6......	52	.50		0	.25		2.25	.72	.26	.75	.31
7......	40	0		0			0			0	
8......	60	1.00		0			1.50	1.20	.50	2.75	1.06
9......	40	2.50		0			2.25	.71	.55	2.75	.96
10......	35	1.50		0			.75	.82	.43	.75	.16
11......	8	1.00		0			.75		.47	.75	
12......	40	0		0			.75	.57	.33	0	
13......	40	.50		0			.75	1.61	.31	0	.15
14......	40	.50		0			0			0	
15......	35	0		0			0			0	
Acreage-weighted averages:		0.527		0	0.035		0.823	0.492	0.212	0.724	0.287

Table 77.--Methyl parathion residues in soil: Area YUA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1......	34	0		0			0			0	
2......	58	0		0			0			3.00	0.03
3......	30	0		0			0			2.00	
4......	30	0		0			0			2.00	
5......	40	2.00		0			3.75			.75	
6......	52	1.00		0			3.75			.75	
7......	40	0		0			0			0	
8......	60	.50		0			3.00			1.00	.02
9......	40	.50		0			4.00			2.50	.05
10......	35	.50		0			.75			3.28	.25
11......	8	0		0			.75			3.28	.07
12......	40	.50		0			4.75			0	
13......	40	0		0			4.75			0	
14......	40	0		0			4.75			0	
15......	35	0		0			4.00			0	
Acreage-weighted averages:		0.377		0			2.454			1.141	0.024

Methyl parathion and ethyl parathion have been used extensively at YUA to control lettuce pests. Because these two insecticides are rapidly broken down and dissipated, it seemed to be unusual to detect either in soil (tables 77 and 78, respectively). A review of the treatment records, however, revealed that the samples with residues were taken shortly after applications of methyl parathion and ethyl parathion.

Table 78.--Ethyl parathion residues in soil: Area YUA

NOTE: Empty spaces indicate no residues detected.

Block	Acres	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
	Number	Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
1.......	34	0		0			0			0	0.01
2.......	58	3.00		0.50			3.00			4.50	.25
3.......	30	2.00		.50			3.00			6.25	.07
4.......	30	2.00		.50			3.00			6.25	.06
5.......	40	4.42		1.50			1.00			6.50	.02
6.......	52	5.25		1.50			1.00			6.50	.03
7.......	40	0		0			0			0	
8.......	60	2.25		.50			3.00			5.00	.23
9.......	40	7.75		.50			1.00			3.38	.05
10.......	35	5.00		.50			2.00			2.42	.31
11.......	8	6.00		.50			2.00			2.56	.28
12.......	40	6.00		.50			1.00			0	
13.......	40	8.25		.50			1.00			0	
14.......	40	9.00		.50			1.00			0	
15.......	35	4.50		.50			2.00			0	
Acreage-weighted averages:		4.294		0.594			1.619			3.049	0.086

D. Paired Crop and Soil Analyses

The crops sampled at YUA included alfalfa, cantaloup, cotton, lettuce, pasture grass, and sorghum. Most of the samples were of cantaloups and lettuce (table 79).

The pesticides used on the crops sampled were DDT, dicofol, ethyl parathion, methyl parathion, endosulfan, and endrin. The pesticides found in the soils taken with the crops were DDT, endrin, dieldrin, endosulfan, benefin, and combined parathion (methyl and ethyl together).

DDT was found in all but one soil sample, in amounts ranging from 0.07 p.p.m. to 11.22 p.p.m. Endrin was also found in most of the soil samples; dieldrin was found in two. Endosulfan and benefin were detected primarily in the 1967 companion soil samples, as was combined parathion.

The crop plant analyses indicate that very few pesticide residues were found in the plant portion of the samples. The chemicals that were found include DDT, endrin, dieldrin, lindane (in one sample), dicofol, and combined parathion (in three samples). With the exception of rather high residue levels of DDT and dicofol in cotton stalks and cantaloup vines, respectively, the residues in crop plants were relatively small. A notable exception to this was 0.65 p.p.m. DDT and 0.23 p.p.m. endrin in an alfalfa sample. The larger residues in cotton stalks and cantaloup vines were apparently due to foliage applications.

The same pesticides found in the crop plants were also detected in samples of the crops. Very few crop samples, however, contained residues. The residues were small, as a rule, and were primarily found in lettuce and cantaloup pulp, seeds, and rind.

When possible, samples of pasture forage were collected from block 1 of YUA, an irrigated pasture separated from blocks where lettuce, cantaloup, and alfalfa were grown by the main irrigation canal.

Table 79.—Pesticide residues in paired crop and soil samples: Area YUA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Year and crop	Block	Amount applied: DDT	Dicofol	Ethyl parathion	Methyl parathion	Endosulfan	Endrin	Soil analyses: Combined DDT	Endrin	Dieldrin	Endosulfan	Benefin	Combined parathion
1965		Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	Lb./acre	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Alfalfa.......	1	0	0	0	0	0	0	0.12					
Alfalfa.......	4	0	0	0	0	0	0	1.85	0.16				
	4	0	0	0	0	0	0	1.77	.16				
Cantaloup.....	5	0	0.14	0	0	0	0	.86	.20				
Lettuce.......	5	0	0	0	0	0	0	.68	.16		0.24		
Cotton........	14	2.00	.11	0	0	0	0	4.15	.46	0.13			
1966													
Alfalfa.......	4	0	0	3.00	0	0	0	1.79	.12				0.53
Cantaloup.....	14	0	0	0	0	0	0	3.20	.28				
Lettuce.......	14	0	0	1.00	4.75	0	0.78	6.13	.67	.10		0.34	
1967													
Grass.........	1	0	0	0	0	0	0	.07					
Alfalfa.......	2	0	0	.50	0	0	0	1.71	.11				
Lettuce.......	2	11.00	0	4.00	3.00	0	0	7.00	.15			.56	.10
Alfalfa.......	3	0	0	.50	0	0	0	1.31	.18				
Lettuce.......	3	6.00	0	5.75	2.00	0.75	0	3.75	.20		.28	.36	.07
Alfalfa.......	4	0	0	.50	0	0	0	2.24	.17		.07		
Lettuce.......	4	6.00	0	5.75	2.00	.75	0	4.24	.24		.29	.34	.08
Cantaloup.....	5	0	.19	0	0	0	0	.90	.24		.13	.05	
Lettuce.......	5	0	0	6.50	.75	.75	.77	.94	.35		.29	.14	.03
Cantaloup.....	6	0	.19	0	0	0	0	.59	.20		.07		
Lettuce.......	6	0	0	6.50	.75	.75	.77	.98	.32		.53	.18	.05
Cantaloup.....	8	0	0	0	0	0	0	5.38	.19		.87	.16	
Lettuce.......	8	0	0	5.00	2.50	2.75	0	4.30	.20		1.19	.38	.20
Cantaloup.....	9	0	.19	0	0	.25	0	2.43	.41		.27	.07	
Lettuce.......	9	0	0	3.38	2.50	2.50	0	2.53	.25		.88	.44	.14
Sorghum.......	10	0	0	0	0	0	0	2.53	.37		.10	.05	
Lettuce.......	10	10.00	0	2.42	3.28	.75	0	11.22	.32			.41	1.08
Sorghum.......	11	0	0	0	0	.75	0	2.26	.30		.21	.05	.39
Lettuce.......	11	10.00	0	2.56	3.28	0	0	7.22	.31			.96	.41
Cantaloup.....	12	0	0	0	0	0	0	6.28	.45			.26	
Cantaloup.....	13	0	.19	0	0	0	0	6.80	.34		.14	.40	
Sorghum.......	13	0	0	0	0	0	0	4.63	.23		.09		
Cantaloup.....	14	0	.19	0	0	0	0	4.66	.31			.14	
Sorghum.......	14	0	0	0	0	0	0	4.47	.19		.13		
Cantaloup.....	15	0	.19	0	0	0	0	4.68	.06				
Sorghum.......	15	0	0	0	0	0	0	4.26	.05				

Year and crop	Block	Crop plant analyses: Combined DDT	Endrin	Dieldrin	Lindane	Dicofol	Combined parathion	Crop analyses: Combined DDT	Endrin	Dieldrin	Combined parathion	Dicofol
1965		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Alfalfa.......	1	0.07										
Alfalfa.......	4	.22										
	4	.95			0.05			0.87				
Cantaloup.....	5	.10				4.88						
Lettuce.......	5	--	--	--	--	--	--					
Cotton........	14	[1] 23.87	0.15	0.20				.32	0.01	0.01		
1966												
Alfalfa.......	4	.65	.23				1.70	1.00			0.98	
Cantaloup.....	14	.03		.01								
Lettuce.......	14	--	--	--	--	--	--					
1967												
Grass.........	1	--	--	--	--	--	--	.50				
Alfalfa.......	2	--	--	--	--	--	--					
Lettuce.......	2	--	--	--	--	--	--	.03			.07	
Alfalfa.......	3	--	--	--	--	--	--					
Lettuce.......	3	--	--	--	--	--	--				.01	
Alfalfa.......	4	--	--	--	--	--	--				.01	
Lettuce.......	4	--	--	--	--	--	--				.01	
Cantaloup.....	5					12.00						0.24
Lettuce.......	5	--	--	--	--	--	--					
Cantaloup.....	6					1.48						.20
Lettuce.......	6	--	--	--	--	--	--					
Cantaloup.....	8					2.08						.12
Lettuce.......	8	--	--	--	--	--	--					
Cantaloup.....	9					3.84						.21
Lettuce.......	9	--	--	--	--	--	--				.01	
Sorghum.......	10	.09		.02								
Lettuce.......	10	--	--	--	--	--	--				.01	
Sorghum.......	11	.10		.02								
Lettuce.......	11	--	--	--	--	--	--					
Cantaloup.....	12					3.09				.01		.20
Cantaloup.....	13					13.69						.24
Sorghum.......	13	.05	.01	.01							.34	
Cantaloup.....	14					1.34						.16
Sorghum.......	14	.10		.01			.03				.05	
Cantaloup.....	15					2.86				.01		.29
Sorghum.......	15	.05	.01	.01			.04				.14	

[1] Sample collected right after an application of DDT.

Table 80.--Pesticide residues in pasture[1] grass in 1965, 1966, and 1967: Area YUA

NOTE: Empty spaces indicate no residues detected.

Sampling date	DDT	Dieldrin	Endrin	Lindane	Heptachlor epoxide	Combined parathion
1965	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
June 10.......	0.09					
July 2........	.09					
Aug. 6........	.50	0.02				
Aug. 19.......	.47	.01		0.02		
Sept. 8.......	.72	.02				
1966						
Jan. 21.......	.11	.01				
Feb. 28.......						
Mar. 30.......						
Apr. 28.......						
May 20........						
June 29.......	.01				0.01	
Aug. 9........	.13	.01			.03	
Aug. 26.......	.26	.02		.01	.01	
Sept. 30......	.37	.02	0.06		.05	
1967						
Jan. 24.......						
Mar. 6........						0.05

[1] Block 1.

None of the pesticides detected in pasture grass were used on block 1 of YUA, but most of them were used on nearby fields, indicating that pesticide drift does result in some residues in pasture forage at YUA (table 80).

E. Water Analyses

The irrigation water sample data for blocks 1, 4, 5, and 14 of YUA are listed in tables 81, 82, 83, and 84, respectively. A quick examination of these tables shows that the DDT complex, dieldrin, methyl parathion, endrin, endosulfan, ethyl parathion, dicofol, DEF, demeton, and trifluralin were detected in irrigation water at YUA. As reported for the other study areas, combined DDT, endrin, and dieldrin are the chemicals most frequently found in water. All residues in water were less than 1.0 p.p.b. for the most part.

Further examination of the irrigation water data for YUA reveals that water entering a block contains relatively few pesticide residues and that as it exits from a block, residues are more in evidence. This seems to indicate that some pesticides, at least, are picked up from the soil by irrigation water and carried out of the fields at YUA.

Table 81.--Pesticide residues in irrigation water in 1965, 1966, and 1967: Block 1, Area YUA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Sampling Date	Rainfall[1]	DDT		DDE		Dieldrin		Methyl parathion		Dicofol		Endosulfan		Ethyl parathion	
		Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit
1965	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Feb. 2..........															
Feb. 26.........															
Mar. 26.........															
Apr. 8 & 9......	0.01														
Apr. 17 & 18....			--		--		--		--		--		--		--
Apr. 25.........			--		--		--		--		--		--		--
May 1...........															
May 15 & 16.....															
May 24..........															
May 29..........															
June 20.........															
July 5..........															
July 21 & 22....					0.00008										
July 30.........		0.00008		0.00008	.00012										
Aug. 9..........				.00008											
Aug. 16.........				.00008	.00026										
Nov. 11 & 12....															
1966															
Jan. 10 & 11....															
Feb. 12.........															
Feb. 26.........															
Mar. 10.........															
Apr. 5..........					.00011										
Apr. 14 & 15....				.00010	.00012	0.00008									
Apr. 23.........															
May 5 & 6.......															
May 13 & 14.....															
May 26..........															
June 3..........															
June 15 & 16....															
June 20.........	Trace[2]														
June 23.........															
June 30 & July 1															
July 12 & 13....															
July 28.........															
Aug. 17.........	.22														
Aug. 26.........															
Aug. 30.........															
Sept. 10 & 11...															
Nov. 6 & 7......															
Nov. 25.........															
Nov. 29.........		.00022						0.00019							
Dec. 8..........															
Dec. 24.........		.00012						.00005	0.00010	0.00010	0.00033	0.00006	0.00014	0.00020	0.00030
1967															
Jan. 27.........			0.00019								.00016		.00011		.00008
Feb. 7 & 8......			.00001								.00006		.00007		
Mar. 14 & 15....		.00016	.00027							.00016	.00065		.00008		

[1] Rainfall listed was recorded on the sampling date, one day before, or both.
[2] Less than 0.01 inch.

Although only a few samples of quick-runoff water were collected at YUA, the residue data for them (table 85) appear to substantiate the findings previously discussed for irrigation water. Essentially the same pesticides were detected in quick-runoff water, and many of the residues were greater than 1.0 p.p.b. (see endrin, endosulfan, dicofol, and methyl parathion residues in the table).

Table 82.--Pesticide residues in irrigation water in 1965, 1966, and 1967: Block 4, Area YUA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Sampling Date	DDT		DDE		Endrin		Dieldrin		Methyl parathion		Endosulfan		Ethyl parathion		Dimethoate		Dicofol	
	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit
1965	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Feb. 25 & 26.........																		
Mar. 26..............																		
Apr. 25..............		--		--		--		--		--		--		--		--		--
May 17...............	--		--		--		--		--		--		--		--		--	
May 28...............	--		--		--		--		--		--		--		--		--	
June 19..............																		
Sept. 28.............																		
Oct. 7...............																		
Oct. 27 & 28.........																		
1966																		
Jan. 10 & 11.........																		
Feb. 22 & 23.........																		
Mar. 9...............						0.00005												
Apr. 2 & 3...........				0.00012		.00029		0.00010										
Apr. 13..............			0.00013	.00018		.00018												
May 3................																		
May 13...............																		
May 31 & June 1......																		
June 3...............																		
June 14..............																		
June 29..............																		
July 14..............																		
Oct. 6...............		0.00028				.00043				0.00028				0.02715				
Oct. 21..............		.00018				.00015		.00002		.00040				.00178				
Nov. 1...............		.00015				.00028				.00020				.00030				
Nov. 29..............	0.00059									.00127								
Dec. 13 & 14.........										.00013				.00011				
1967																		
Jan. 12..............	.00018	.00012									0.00004	0.00028		.00030			0.00048	0.00032
Feb. 7...............		.00017										.00028		.00008			.00014	.00020
Mar. 8...............	.00010	.00017										.00022		.00009				
Mar. 17..............	.00026												0.00003	.10000			.00015	

Table 83.--Pesticide residues in irrigation water in 1965, 1966, and 1967: Block 5, Area YUA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Sampling date	Rainfall[1]	DDT		DDE		TDE		Endrin		Dieldrin		Endosulfan	
		Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit
1965	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Jan. 28		--		--		--		--		--		--	
Mar. 13 & 14													
Apr. 22 to Apr. 24					0.00006				0.00023				
May 9 & 10			0.00021		.00008		0.00026		.00036				
May 20 & 21			.00028		.00009				.00041				
May 28													
July 8			.00008		.00019								
Aug. 13			.00037	0.00011	.00022				.00084		0.00008		
Sept. 29 & Oct. 1													
Oct. 14 & 15			.00167		.00013						.00009		
Oct. 26 to Oct. 28			.00035		.00024				.00227		.00109		
Nov. 11 & 12									.00581				0.01423
Dec. 4			.00011		.00012				.00178				.00178
1966													
Feb. 7 & 12	0.21+		.00012		.00009		.00018		.00128				.00016
Mar. 3 & 4									.00025				
Apr. 8 & 11			.00021		.00024				.00090		.00008		
May 4 & 5													
May 14													
May 25													
July 16			.00059		.00019				.00078				
Aug. 18 & 19	.22		.00035		.00018				.00176				
Oct. 7 & 10									.00025				
Oct. 11 & 12					.00009				.00077				
Oct. 20 & 21								0.00014	.00046				.00144
Oct. 25		0.00042				0.00121			.02721				.00138
Nov. 10			.00021				.00099		.00134			0.00249	.00303
Nov. 30		.00011						.00009	.00104			.00006	.02550
Dec. 15		.00033	.00084									.00004	.01992
Dec. 28 & 29		.00011	.00089										
1967													
Jan. 11		.00015	.00031									.00078	.01070
Jan. 21 to Jan. 23	.23		.00015										.01519
Feb. 23 & 24		.00015	.00038										.00054
Mar. 8 & 9			.00028										.00064
Apr. 20 & 21									.00040				
May 12 & 13					.00010				.00100				
July 25 & 26					.00010				.00040				
Sept. 14 & 15									.00070				
Oct. 12									.00471				
Nov. 2									.00453				.00477

Sampling date	Rainfall[1]	Dicofol		Methyl parathion		Ethyl parathion		DEF		Benefin		Demeton		Disulfoton	
		Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit
1965	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Jan. 28		--		--		--		--		--		--		--	
Mar. 13 & 14															
Apr. 22 to Apr. 24															
May 9 & 10															
May 20 & 21															
May 28															
July 8															
Aug. 13															
Sept. 29 & Oct. 1															
Oct. 14 & 15															
Oct. 26 to Oct 28															
Nov. 11 & 12															
Dec. 4			0.00070												
1966															
Feb. 7 & 12															
Mar. 3 & 4															
Apr. 8 & 11															
May 4 & 5															
May 14															
May 25															
July 16															
Aug. 18 & 19															
Oct. 7 & 10					0.00097										
Oct. 11 & 12								0.02035							
Oct. 20 & 21					.00169										
Oct. 25				0.00040	.02043		0.00038								
Nov. 10				.00019			.00038								
Nov. 30				.01138	.00374	0.00368	.00951								
Dec. 15		0.00017			.01300		.11000								
Dec. 28 & 29		.00016	.00687		.00070		.00400								
1967															
Jan. 11		.00029	.00167	.01300	.00300		.00030								
Jan. 21 to Jan. 23	.23				.00200		.00900								
Feb. 23 & 24		.00040	.00145												
Mar. 8 & 9			.00029												
Apr. 20 & 21											0.00010				
May 12 & 13											.00020				
July 25 & 26															
Sept. 14 & 15												0.00189	.00017		
Oct. 12					.00095	.00002	.00057					.00047	.00013		
Nov. 2						.00002	.00074					.00152	.00171		0.00009

[1] Rainfall listed was recorded on the sampling date, one day before, or both.

Table 84.--Pesticide residues in irrigation water in 1965, 1966, and 1967: Block 14, Area YUA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Sampling Date	Rainfall	DDT		DDE		TDE		Endrin		Dieldrin		Methyl parathion	
		Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit
1965	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Feb. 23 & 24..........													
May 4 & 5.............			--		--		--		--		--		--
May 26................		--	0.00025	--	0.00023	--		--		--		--	
June 14...............			--		--		--		--		--		--
June 28 & 29..........			.00008		.00016		0.00029		0.00038		0.00008		
July 13...............				0.00008	.00015				.00041				
July 22...............			--	.00008	--		--		--		--		--
Aug. 4 & 5............		0.00008	.00021	.00008	.00035				.00046		.00008		
Aug. 19...............			.00024		.00017								
Sept. 14 & 15.........									.00097		.00057		
1966													
Mar. 3 & 6............					.00008								
Apr. 22 & 23..........			.00064	.00008	.00028				.00041		.00010		
May 10 & 11...........			.00047		.00032				.00030		.00014		
May 22 & 23...........		.00011	.00560		.00148				.00245		.00110		
June 2................		.00029	.00046		.00035				.00019		.00011		
July 17...............		.	.00044		.00019				.00091				
Sept. 21 & 26.........			.00075		.00024				.00038				
Oct. 11...............			.00131						.00753			0.00015	0.00453
Oct. 26 & 27..........		.00053	.00787						.00856		.00084	.00140	.12504
Nov. 7 & 8............	Trace[1]	.00031	.04581		.00103	0.00300			.01390			.00033	
Nov. 17 & 18..........			.01161					0.00015	.00995			.00010	.02236
Dec. 2................		.00010	.02142		.00035			.00012	.00780		.00017	.00008	.00452
Dec. 14...............		.00017	.05483					.00004	.01355				.01783
1967													
Feb. 5 & 7............		.00019	.00085										.00030
Feb. 23 & 24..........		.00016	.00044		.00004								
Apr. 4 & 6............													
May 10 & 12...........			.00120		.00030				.00100				
June 7 & 8............					.00010				.00040				
July 24 & 25..........			.00320		.00030				.00100				
Aug. 17...............			.00120		.00044				.00088		.00010		.00001
Sept. 15..............			.06581		.00229		.00014		.00331		.00026		
Oct. 12 & 13..........			.00123		.00045				.00252		.00005		.00011

Sampling Date	Rainfall	Dicofol		Endosulfan		Ethyl parathion		DEF		Benefin		Demeton	
		Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit	Entry	Exit
1965	In.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Feb. 23 & 24..........													
May 4 & 5.............			--		--		--		--		--		--
May 26................		--		--		--		--		--		--	
June 14...............			--		--		--		--		--		--
June 28 & 29..........													
July 13...............													
July 22...............			--		--		--		--		--		--
Aug. 4 & 5............													
Aug. 19...............													
Sept. 14 & 15.........													
1966													
Mar. 3 & 6............													
Apr. 22 & 23..........													
May 10 & 11...........													
May 22 & 23...........													
June 2................													
July 17...............													
Sept. 21 & 26.........													
Oct. 11...............							0.00317	0.00738					
Oct. 26 & 27..........													
Nov. 7 & 8............	Trace[1]			0.00060	0.02814	0.00019							
Nov. 17 & 18..........				.00032	.00292								
Dec. 2................				.00114	.00063	.00077	.11836						
Dec. 14...............				.00002	.00020		.00752						
1967													
Feb. 5 & 7............					.00086		.00020						
Feb. 23 & 24..........		0.00088	0.00010		.00014								
Apr 4 & 6.............													
May 10 & 12...........											0.00040		
June 7 & 8............													
July 24 & 25..........											.00030		
Aug. 17...............												0.00013	0.00013
Sept. 15..............												.00012	.00013
Oct. 12 & 13..........												.00012	.00012

[1] Less than 0.01 inch.

Table 85.--Pesticide residues in quick runoff water in 1965 and 1966: Area YUA

NOTE: Empty spaces indicate no residues detected.

Sampling date	Rainfall[1]	Block	DDT	DDE	TDE	Endrin	Endosulfan	Dicofol	Methyl parathion
1965	In.		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.
Feb. 7	0.75	1							
Dec. 11	.90	5			0.00008	0.00368	0.00414	0.0041	
Dec. 15	.17+	5			.00045	.00677	.00370	.02800	
Dec. 17	.42+	5	0.00023	0.00037	.00073	.00219	.00615	.00605	
1966									
Oct. 4	.53	5	.00053	.00002			.00418		
Do	....do...	14	.00005				.00171		0.01081

[1] Rainfall listed was recorded on the sampling date, one day before, or both.

F. Terrestrial Organisms Analyses

Aquatic organisms were not sampled at YUA because those available were not restricted to the area, i.e., they could move up or down the canals to or from any place in the valley. The only exception to this was the single sample of algae taken from one of the lateral ditches at YUA.

The terrestrial organisms sampled were mice, gophers, ground squirrels, rabbits, toads, earthworms, lizards, snakes, and white grubs (table 86).

Combined DDT and dieldrin were found in relatively small amounts in most of the small mammals collected at YUA. Relatively large amounts of combined DDT and dieldrin were found in toads, and large amounts of combined DDT and endrin were detected in YUA earthworms. Moderate amounts of combined DDT and dieldrin were found in lizards and snakes, while small amounts were found in white grubs and algae.

For the most part, the organisms with smaller residue levels were collected from the pastures at YUA or from small patches of land not used at all (brush-covered land or sand dunes) but located within the boundaries of the study area.

Sampling of terrestrial organisms was too limited at YUA in 1967 to detect any buildup or reduction of residue levels.

Table 86.--Pesticide residues in terrestrial and aquatic organisms: Area YUA

NOTE: Empty spaces indicate no residues detected, and dashes indicate no sample was analyzed or no information was available.

Organisms	1965 sampling season						1966 sampling season						1967 sampling season				
	Date of sampling	DDT	TDE	DDE	Dieldrin	Endrin	Date of sampling	DDT	TDE	DDE	Dieldrin	Endrin	Date of sampling	DDT	TDE	DDE	Dieldrin
		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.		P.p.m.	P.p.m.	P.p.m.	P.p.m.
Reithrodontomys megalotis.. (Western harvest mouse)	Dec. 13, 1965......	0.62	0.03	2.81	0.32		--	--	--	--	--	--	--	--	--	--	--
Mice(unident.).............	--	--	--	--	--	--	Apr. 18 to May 2, 1966		0.01	0.17	0.03		--	--	--	--	--
	--	--	--	--	--	--	Jan 30, 1967.......	1.27	.05	.77	.04		--	--	--	--	--
Thomomys bottae albotus.... (gophers)	Feb. 26, 1965......	.19		.23	.05		May 2, 1966........			.04	.01		May 26, 1967.......	0.05	0.02	0.10	0.03
	Jan. 10, 1966......	.05		.14	.04		Jan 27, 1967.......	.03	.02	.05	.03		--	--	--	--	--
Citellus harrisii.......... (ground squirrel)	Apr. 10, 1965......	.05	.03	.07	.05		May 2, 1966........	.05	.02	.04	.05		--	--	--	--	--
Sylvilagus audobonii....... (rabbits)	Apr. 6 to Apr. 24, 1965	.02		.01	.01		May 2 to May 5, 1966						May 24 to May 26, 1967.....				
	Dec. 13, 1965......	.02		.02	.01		Dec. 30, 1966 to Jan 26, 1967........										
	--	--	--	--	--	--							--	--	--	--	--
Bufo punctatus (toads).....	Apr. 30, 1965......	21.92	1.89	36.25	1.44		Jan 30, 1967.......	.37		2.01	.04		--	--	--	--	--
	Jan. 10, 1966......	7.82	.19	46.06	.58		--	--	--	--	--	--	--	--	--	--	--
Earthworms.................	Jan. 1, 1966.......	3.60	.70	2.04		0.47	March 29, 1966......	.34	.24	.38		0.08	--	--	--	--	--
	Jan. 4, 1966.......	2.20	.84	2.70		1.00	Apr. 12, 1966.......		4.08	5.07	.41	1.58	--	--	--	--	--
	--	--	--	--	--	--	Jan 26, 1967........	17.60	2.66	10.73	.79	6.02	--	--	--	--	--
Cremidophorus tesselatus (lizard)	--	--	--	--	--	--	May 2, 1966.........	.06	.03	2.32	.02		Spring.............	.10	.03	2.79	.01
	--	--	--	--	--	--	Jan. 30, 1967.......	.01		.06	.01		--	--	--	--	--
Sceloporus cyanogenys...... (lizard)	--	--	--	--	--	--	May 2, 1966.........	.10		.46	.05		--	--	--	--	--
Lampropeltis getulus niger (black kingsnake)	--	--	--	--	--	--	May 2, 1966.........	.70	.22	3.73	.52		--	--	--	--	--
Pituophis sayi affinis..... (bullsnake)	--	--	--	--	--	--	May 2, 1966..........			.06	.03		--	--	--	--	--
White grubs................	--	--	--	--	--	--	Apr. 1, 1966.........	.20	.09	.45	.08	.09	--	--	--	--	--
Algae......................	Jan. 13, 1965.......	.49	.08	.12			--	--	--	--	--	--	--	--	--	--	--

ARSENIC ANALYSES IN SOILS FROM ALL SIX STUDY AREAS

Arsenic analyses are being presented separately and at the end of the report because of the nature of the arsenic data (table 87). There was little consistency in selecting samples for arsenic analysis. The main reason for this was the large volume of samples that had to be analyzed for the pesticides still widely used (time would not permit further arsenic work).

The history of arsenic compound applications before 1965 is questionable as presented in the table, because the use of arsenic compounds as defoliants was formerly a common practice in the Delta areas. As reported earlier, the records kept during the study were accurate.

The data as reported here are not adequate to determine trends in arsenic levels in soils. The only thing that might be said is that arsenic is apparently very persistent in soils. There seems to be little accumulation of arsenic in soils, based on the rather limited number of blocks sampled each year that had a record of treatment with an arsenic compound.

Table 87.--Arsenic residues in soil: Six intensive study areas

NOTE: Dashes indicate no samples were analyzed or no information was available.

Area	Block	Amount applied before 1965	1965			1966			1967		
			Spring	Amount applied	Fall	Spring	Amount applied	Fall	Spring	Amount applied	Fall
		Lb./acre	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.	P.p.m.	Lb./acre	P.p.m.
CHA....	2	0	2.53	0	--	--	0	--	--	--	--
	5	0	6.37	0	--	7.97	0	--	--	--	--
	6	0	4.10	0	--	--	0	--	--	--	--
	10	0	4.30	0	--	--	0	--	--	--	--
	14	0	1.20	0	--	1.93	[1] 1.26	3.63	--	--	--
GRA....	1	0	12.70	0	--	10.53	0	8.67	--	--	--
	2	0	8.67	0	--	7.40	0	7.93	--	--	--
	8	0	5.87	0	--	--	[1] .50	7.33	--	--	--
STB....	5	0	5.70	0	--	11.93	0	6.70	--	--	--
	7	0	5.43	0	--	9.47	0	6.80	--	--	--
	10	0	5.27	0	--	9.03	0	6.50	--	--	--
NMA....	1	--	--	0	--	5.80	0	--	--	0	--
	2	--	--	0	--	5.37	0	--	--	0	--
	3	--	4.77	0	3.57	5.43	0	4.37	9.83	0	--
	4	--	--	0	--	4.13	0	--	--	0	--
	5	--	--	0	--	4.57	0	--	--	0	--
	6	--	--	0	--	4.37	0	--	--	0	--
	7	--	--	0	4.53	4.47	0	4.60	9.93	0	--
	8	--	--	0	--	4.80	0	--	--	0	--
	9	--	--	0	--	5.07	0	--	--	0	--
	10	--	--	0	4.03	4.27	0	5.77	9.57	0	--
SMO....	1	0	4.30	0	--	--	0	--	--	0	--
	2	0	2.53	0	--	1.90	0	--	2.07	0	--
	3	0	7.87	0	--	--	0	--	--	0	--
	4	0	5.73	0	--	--	0	--	--	0	--
	5	0	.37	0	--	--	0	--	--	0	--
	6	0	.73	0	--	--	0	--	--	0	--
	7	0	3.00	0	--	--	0	--	--	0	--
	8	0	1.67	0	--	--	[2] 4.00	--	--	[2] 2.50	--
	9	[2] 4.00	1.37	[2] 4.60	--	--	[2] 4.67	--	--	[2] 3.33	--
	10	[2] 2.67	5.17	[2] 4.13	--	--	[2] 2.40	--	--	[2] 1.76	--
	11	[2] 3.68	2.87	.48	--	--	0	--	--	0	--
	12	0	3.13	[2] 1.60	--	--	0	--	--	0	--
	13	0	2.73	0	--	--	0	--	--	0	--
	14	0	5.47	0	--	2.93	0	--	2.13	0	--
	15	0	10.17	[2] 4.00	--	5.60	0	--	3.70	0	--
	16	0	.43	0	--	--	0	--	--	0	--
	17	0	1.53	0	--	--	0	--	--	0	--
	18	0	4.23	0	--	--	0	--	--	0	--
	19	0	2.40	0	--	--	0	--	--	0	--
YUA....	1	0	2.30	0	--	2.67	[1] 14.00	--	--	0	2.33
	2	0	3.80	0	--	--	0	--	--	0	--
	3	0	6.40	0	--	6.33	[1] 4.00	--	--	[1] 1.33	4.20
	4	0	4.87	0	--	--	0	--	--	0	--
	5	0	--	0	2.30	--	0	--	--	0	--
	6	0	--	0	4.00	--	0	--	--	0	--
	7	0	1.77	0	--	--	0	--	--	0	--
	8	0	--	0	3.00	5.57	0	--	--	0	--

[1] MSMA. [2] Sodium arsenite.

SUMMARY AND COMMENTS

In 1964 and early in 1965, several 1-square-mile study areas were established for monitoring agricultural pesticide residues in soil, crops, water, sediment, and wildlife. The objectives were to determine existing pesticide residue levels and to detect any changes in those levels that might occur during the study.

Soil was sampled before and after the pest-control season each year. Water was regularly collected from contain surface sources, quick-runoff after heavy rainfall, irrigation sources, and potable wells. Samples of sediment were collected with water samples from contained sources and quick-runoff. Each different crop grown was sampled at or near harvest. Paired samples of soil and crop were collected. Pasture forage was sampled when available, to detect possible contamination of forage from pesticide drift. Local species of aquatic and terrestrial organisms were sampled before and after the pest-control season each year the study was conducted.

Records of cropping practices and pesticide applications were kept at each area during the study. Records of pesticide use before 1964 were also compiled.

All samples were analyzed for pesticides at the USDA Pesticides Monitoring Laboratory in Gulfport, Miss., using the latest methods and finest equipment available.

Soil analyses indicate that residue levels of the more persistent pesticides such as DDT (including the TDE and DDE isomers), dieldrin, and endrin did not change appreciably during the study period. Residues in soils were generally higher in the fall than in the spring, particularly when applications of the respective pesticides were made between the spring and fall sampling.

As might be expected, the largest residues in soils were usually found in the fields where the greatest amounts had been used.

Analyses of paired crop and soil samples show a wide variety of pesticides and amounts recovered. Residues of combined DDT, endrin, and dieldrin were the most frequently found, however. Residues of at least one of these three chemicals were detected in 88 percent of the 17 crops sampled at the seven study areas. DDT was found in 76 percent of the crop samples; endrin and dieldrin were each found in 30 percent of the crop samples. The only other pesticides found in the crop samples were methyl and ethyl parathion and dicofol, but these chemicals were detected in only a few scattered samples at Yuma, Ariz.

Residue levels found in crop samples were generally below 0.1 p.p.m. Somewhat higher levels were found in crop plant samples but were principally the result of foliage applications before sampling. It does appear, however, that translocation of pesticides from the soil into crops does occur in the areas where samples were collected. Some residues were found in crops and crop plants taken from fields that were not treated with the pesticides found during the period of study.

Water sample analyses indicate that only very small amounts of pesticides were present in any of the sources sampled. By and large, the levels detected were below 1 part per billion. DDT, its metabolites TDE and DDE, and dieldrin were the most prevalent pesticides in water. Residues of any pesticide were most frequently found in contained surface sources and in exit water at Yuma, Ariz., indicating that pesticides are carried into water sources from cropland by normal drainage or irrigation. Quick-runoff water data also indicate that pesticide residues are picked up from the soil by runoff water and are carried into water sources with sediment.

Analysis of sediment shows residues in the magnitude of decimal fractions of a part per million to a high of 4.90 p.p.m. DDT and its isomers, TDE and DDE, were the principal pesticides found in sediment from any of the areas where it was collected. Dieldrin and endrin, however, were also found in sediment from Greenville, Miss.; Stuttgart, Ark.; and Theodore, Ala. These pesticides evidently entered the ponds in sediment carried from fields by drainage water.

Nearly all of the organisms sampled at the seven study areas contained measurable amounts of DDT and/or one of its isomers (particularly DDE).

The highest levels of these chemicals were found in bird eggs and fish, while the lowest levels were found in small mammals.

Dieldrin was found in nearly half or more of the organisms sampled, in amounts generally below 0.5 p.p.m. The highest levels were found in birds and invertebrates and the lowest levels in small mammals.

Endrin residues were detected in a relatively small percentage of the wildlife samples. The highest levels were found in invertebrates and birds and the lowest levels in small mammals.

Although pesticide residues found in bird eggs were large in comparison with those in the other organisms sampled, the levels in nestling birds from the same hatch were much lower, indicating that a large proportion of the residues found in eggs are lost by the time of hatching.

Other pesticides found at low levels in relatively few wildlife samples were aldrin, benzenehexachloride (BHC), chlordane, ethion, heptachlor epoxide, and lindane.

LIST OF PESTICIDES REFERRED TO IN THIS REPORT

aldrin--Insecticide--not less than 95% of 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo-exo-5,8-dimethanonaphthalene

amiben--Herbicide--3-amino-2,5-dichlorobenzoic acid

Aramite--Acaricide--2-(p-tert-butylphenoxy) isopropyl-2-chloroethyl sulfite

arsenic--Insecticide and Herbicide--Analysis based on determination of inorganic or elemental arsenic

atrazine--Herbicide--2-chloro-4-ethylamino-6-isopropylamino-s-triazine

azinphosethyl--Insecticide--0,0-diethyl S(4-oxo-1,2,3-benzotriazin-3 4H ylmethyl) phosphorodithioate

azinphosmethyl--Insecticide--0,0-dimethyl S(4-oxo-1,2,3-benzotriazin-3 4H ylmethyl) phosphorodithioate

Balan (benefin)--Herbicide--N-butyl-n-ethyl-alpha, alpha, alpha, trifluoro-2,6-dinitro-p-toludine

BHC (benzene hexachloride)--Insecticide--1,2,3,4,5,6-hexachlorocyclohexane, consisting of several isomers with a specified % of gamma

Bidrin--Insecticide--3-hydroxy-n,n-dimethyl-cis-crotonamide dimethyl phosphate

binapacryl--Acaricide and Herbicide--2-sec-butyl-4,6-dinitrophenyl-3-methyl-2-butenoate

Bomyl--Insecticide--dimethyl-3-hydroxyglutaconate-dimethyl phosphate

Bulan--Insecticide--1,1-bis(p-chlorophenyl)-2-nitrobutane

calcium cyanide--Fumigant--$Ca(CN)_2$

captan--Fungicide--N-(trichloromethylthio)-4-cyclohexene-1,2-dicarboximide

carbaryl--Insecticide--1-naphthyl methylcarbamate

carbophenothion--Insecticide and Acaricide--3-[(p-chlorophenylthio) methyl]-0,0-diethyl phosphorothioate

CDEC--Herbicide--2-chlorallyl diethyldithiocarbamate

Ceresan--Fungicide--ethylmercuric chloride (or C_2H_5HgCl)

chlorbenside--Acaricide--p-chlorobenzyl-p-chlorophenyl

chlordane--Insecticide--1,2,3,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene

chlorobenzilate--Acaricide--ethyl 4,4-dichlorobenzilate

Ciodrin--Insecticide--alpha-methylbenzyl 3-(dimethoxyphosphinyloxy)-cis crotonate

coumaphos--Insecticide--0,0-diethyl 0-3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl phosphorothioate

2,4-D--Herbicide--2,4-dichlorophenoxyacetic acid

dalapon--Herbicide--2,2-dichloropropionic acid, sodium salt

2,4-DB--Herbicide--2,4-dichlorophenoxybutyric acid

DDT--Insecticide--1,1,1-trichloro-2,2-bis (p-chlorophenyl)ethane

DEF--Defoliant--S,S,S-tributyl phosphorotrithioate

demeton--Insecticide--mixture of 0,0-diethyl s and 0-2-(ethylthio) ethyl phosphorothioates

Demosan--Fungicide--1,4-dichloro-2,5-dimethoxybenzene

diazinon--Insecticide--0,0-diethyl 0-(2-isopropyl-4-methyl-6-pyramidyl) phosphorothioate

dichlone--Fungicide and Herbicide--2,3-dichloro-1,4-naphthoquinone

dichlorvos--Insecticide--2,2-dichlorovinyl dimethyl phosphate

dicofol--Acaricide--4,4'-dichloro-alpha-trichloromethylbenzhydrol

dieldrin--Insecticide--not less than 85% of 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-exo-5,8-dimethanonaphthalene

Dilan--Insecticide--mixture of Prolan and Bulan

dimethoate--Acaricide and Insecticide--0,0-dimethyl S-(N-methylcarbamoylmethyl) phosphorodithioate

dinocap--Acaricide and Fungicide--2-(1-methyl-n-heptyl)-4,6-dinitrophenyl crotonate

dioxathion--Acaricide and Insecticide--2,3-p-dioxane S,S-bis(0,0-diethylphosphorodithioate

diphenamid--Herbicide--N,N-dimethyl-2,2-diphenylacetamide

disulfoton--Insecticide and Acaricide--0,0-diethyl S-2-(ethylthio)ethyl phosphorodithioate

Dithane M-45--Fungicide--coordination product of zinc ion and manganese ethylene bisdithiocarbamate 80%

diuron--Herbicide--3-(3,4-dichlorophenyl)-1,1-dimethyl urea

DNBP and DNOSBP--Herbicides--dinitrobutylphenol

DSMA--Herbicide--CH_3 AsO (O Na)$_2$

endosulfan--Insecticide--6, 7, 8, 9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepan 3-oxide

endothall--Herbicide--7-oxabicyclo-(2.2.1)-heptane-2,3-dicarboxylic acid

endrin--Insecticide--1,2,3,4,10,10-hexachloro-6, 7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1, 4-endo-endo-5,8-dimethanonaphthalene

EPN--Acaricide and Insecticide--0,ethyl 0-p-nitrophenyl phenylphosphonothioate

ethion--Acaricide and Insecticide--0,0,0',0'-tetraethyl S,S'-methylene bis-phosporodithioate

ethyl parathion--Insecticide--0,0-diethyl-0-p-nitrophenyl phosphorothioate

fenthion--Insecticide--0,0-dimethyl 0-[4-(methylthio)-m-tolyl] phosphorothioate

Folex--Defoliant--see Merphos

folpet--Fungicide--N-trichloromethylthiophthalimide

Genite 923--Acaricide--2,4-dichlorophenyl ester of benzenesulfonic acid

heptachlor--Insecticide--1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4, 7: 10:10-heptachloro-4:7:8:9-tetrahydro-4:7-endo-methyleneindene

hydroxy-chlordene--Insecticide

Imidan (prolate)--Insecticide--0,0-dimethyl s-phthalimidomethyl phosphorodithioate

isobenzan--Insecticide--1,3,4,5,6,7,8,8-octachloro-1,3,3a,4,7,7a-hexahydro-4,7-methanoiso-benzofuran

isodrin--Insecticide--1, 2, 3, 4, 10, 10-hexachloro-1, 4, 4a, 5, 8, 8a-hexahydro-1, 4-endo-endo-5, 8-dimethanonaphthalene

Kepone--Insecticide--decachlorooctahydro-1,3,4-metheno-2H-cyclobuta (cd) pentalen-2-one

lindane--Insecticide--gamma isomer of 1,2,3,4,5,6-hexachlorocyclohexane of 99 + % purity

linuron--Herbicide--3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea

malathion--Insecticide--S-[1,2-bis(ethoxycarbonyl)ethyl] 0,0-dimethyl phosphorodithioate

maleic hydrazide--Herbicide--1,2-dihydropyridazine-3,6-dione

maneb--Fungicide--ethylenebisdithiocarbamate manganese

MCPA--Herbicide--4-chloro-2-methylphenoxyacetic acid

Merphos--Defoliant--tributyl phosphorotrithioate

methoxychlor--Insecticide--1,1,1-trichloro-2,2-bis (p-methoxyphenyl) ethane

methyl demeton--Insecticide--beta-ethyl mercaptoethyl dimethyl thionophosphate

methyl parathion--Insecticide--0,0-dimethyl 0-p-nitrophenyl phosphorothioate

Methyl Trithion--Insecticide and Acaricide--0,0-dimethyl S-(p-chlorophenylthio)methyl phosphorodithioate

mevinphos--Insecticide--2-carbomethoxy-1-propen-2yl dimethyl phosphate

mirex--Insecticide--dodecachlorooctahydro-1,3,4-metheno-2H-cyclobuta (cd) pentalene

monuron--Herbicide--3-(p-chlorophenyl)-1,1-dimethylurea

Morestan (oxythioquinox)--Acaricide--6-methyl-2-oxo-1,3-dithio (4,5-b) quinoxaline

MSMA--Herbicide--methanearsonic acid, monosodium salt

nabam--Fungicide--disodium ethylene bisdithiocarbamate

naled--Insecticide--1,2-dibromo-2,2-dichloroethyl dimethyl phosphate

Nemacide--Nematocide--0-2,4-dichlorophenyl 0,0-diethyl phosphorothioate

norea--Herbicide--3(hexahydro-4,7-methanoindan-5 yl)-1,1-dimethylurea

ovex--Acaricide--p-chlorophenyl p-chlorobenzenesulfonate

oxydemetonmethyl--Insecticide--S-[2-(ethylsulfinyl)ethyl] 0,0-dimethyl phosphorothioate

Panogen (methylmercuric dicyandiamide)--Fungicide--$C_3H_6N_4Hg$

PCNB--Fungicide--pentachloronitrobenzene

Perthane--Insecticide--1,1-dichloro-2,2-bis(p-ethylphenyl)ethane

phorate--Insecticide--0,0-diethyl S-(ethylthio) methyl phosphorodithioate

Phosdrin--Insecticide--see mevinphos

Prolan--Insecticide--2-nitro-1,1-bis(p-chlorophenyl) propane

prometryne--Herbicide--2-methylmercapto-4,6-bis(isopropylamino)-s-triazine

propanil--Herbicide--3',4'-dichloropropionanilide

ronnel--Insecticide and Acaricide--dimethyl 2,4,5-trichlorophenyl phosphorothionate

Ruelene--Insecticide--4-tert-butyl-2-chlorophenyl methyl methylphosphoramidite

simazine--Herbicide--2-chloro-4,6-bis(ethylamino)-s-triazine

sodium arsenite--Herbicide and Insecticide--$NaAsO_2$

sodium chlorate--Herbicide and Defoliant--$NaClO_3$

sodium fluosilicate--Insecticide--sodium silicofluoride

Strobane--Insecticide--terpene polychlorinates

sulfur--Acaricide and Fungicide

Sulphenone--Acaricide--p-chlorophenyl phenyl sulfone

2,4,5-T--Herbicide--2,4,5-trichlorophenoxyacetic acid

TCNB--Fungicide--1,2,4,5-tetrachloro-3-nitrobenzene

TDE--Insecticide--2,2-bis(p-chlorophenyl)-1,1-dichloroethane

tetradifon--Insecticide and Acaricide--p-chlorophenyl 2,4,5-trichlorophenyl sulfone

Thimet--Insecticide--see phorate

thiram--Fungicide--tetramethylthiuram disulfide

toxaphene--Insecticide--octachlorocamphene

trichlorofon--Insecticide--0,0-dimethyl(1-hydroxy-2,2,2-trichloroethyl) phosphonate

trifluralin--Herbicide--alpha,alpha,alpha,-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine

Vegadex--Herbicide--see CDEC

Zinc sulfate--Fungicide

zineb--Fungicide--zinc ethylene bisdithiocarbamate

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56

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